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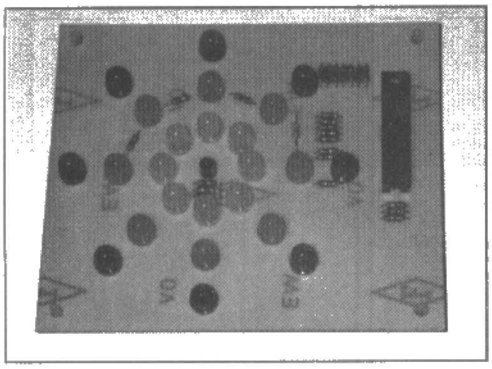

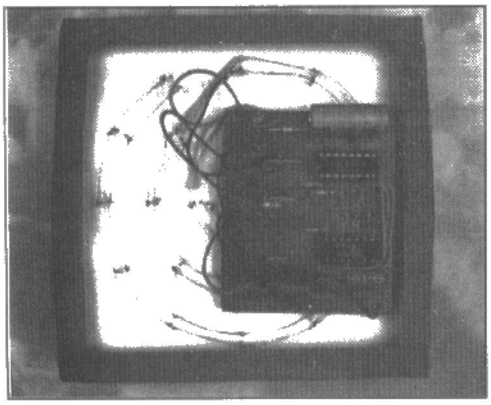

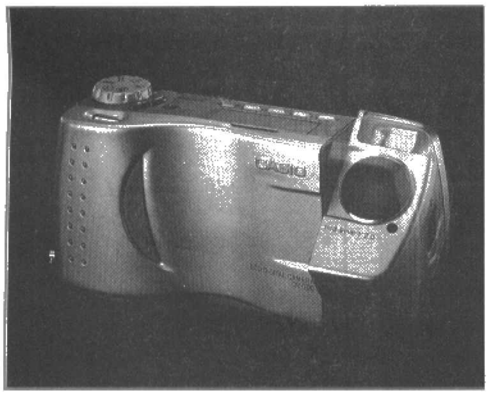

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4-Go Rocket Launcher 23

For the more ambitious rocket modeller, this launch controller by Robin Abbott works with popular rocket kits to fire four rockets simultaneously; or rockets in sequence, or automatic firing at one second intervals or after a traditional 10 second count down.

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Raymond Haigh's receiver design for the serious Medium Wave listener and DX enthusiast has extra front-end selectivity to narrow down the bandwidth of frequencies accepted, improve signal-to-noise ratios and help prevent weak signals being swamped by strong ones.

Fast Fivers 7 - Animated starburst 63

This 'light'weight display by Owen Bishop can decorated in any way you like, and hung in a window or on a Christmas tree. This is a little more ambitious than most of the "Fast Fivers" - good for a dark winter evening messing about with glitter and LEDs. Get the kids to help.

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ETI ELECTRONICS TODAY INTERNATIONAL News...

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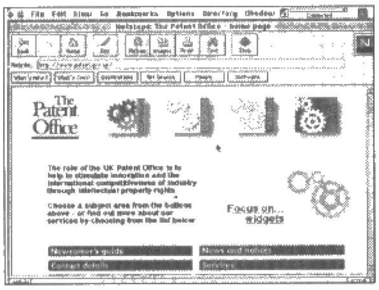
The Patent Office puts intellectual copyright information on the Web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The role of the UK Patent Office is to help to stimulate innovation and the international competitiveness of industry through intellectual property rights

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The UK Patent Office has launched its own Web site at http://www.patent.giv.uk, with access to over 400 pages of information about intellectual property, and the publications and services of the Patents Office. The site is held on the Patent Office's own Web server and will be updated on the day that news or other information arrives at the office.

(X)

The home page offers links into sections on Copyright, Designs, Patents and Trade Marks. There are also links to a Newcomers' Guide (which explains the differences between types of intellectual property), contact details, news pages, publications, prices and commercial search services. Users are helped by an Excite search engine within the site. A section on intellectual property tights on the Internet is intended to be useful to those providing or using on-line material.

Under each of the major headings is a description of the nature of the right described, and the protection is offers, as well as guidance on how to acquire or assert the rights and how, where necessary or appropriate, to renew them.

The Patent Office plans to develop interactive elements on the site to enable users to gain access to forms. In the long term, access to the patent and trade mark databases is under consideration.

The site was designed by the Central Office of Information to be "stylish, easy to load and use, and full of helpful cross-references and useful information." Welcoming the site, minister of state John Battle said: "... the Patent Office Web site provides a valuable resource and point of reference. Innovative businesses, university departments and schools should bookmark this site now." Isaac Asimov would like the idea of bookmarking Internet sites.

The home page also provides a link to a "Focus on a particular technology". The first technology to be featured is the widget or "device for promoting froth", starting with Guinness's first patent on the subject in 1972. The site is clearly being promoted with engineering and technology personnel in mind, although whether the marketing focus is right on target is open to debate, as observation indicates that they tend to prefer real ale and imported beers in chunky bottles.

For more information (on the Patent Office Web site) contact Dave Morgan, the Patent Office, tel. 01633 814703.

Radio Rally at Canvey Island next month

The Thirteenth South Essex Amateur Radio Society Radio and Computer Rally will be held at The Paddocks, Long Road, Canvey Island, Essex at the end of the A130 on 1st February 1998. Doors open at 10.30 am and the Rally features Amateur Radio, computer and electronic component exhibitors, Bring and Buy, RSGB Morse testing on demand (bring two passport photos if you want to take the test) and refreshments. There is free car parking, with space by the main doors for disabled visitors. "One of the biggest and best rallies in Essex, getting bigger every year!" say the organisers. Admission is £1. For more information contact David G4UVJ Tel. 01268 697978.

New Amateur 136 kHz Receiver Kit

Cambridge Kits have produced a receiver kit for the new amateur band on 136 kilohertz. This is a lower-cost version of their 60 kHz receiver, originally designed for their MSF Clock, with details for modification to 136 kHz. The compact receiver features a narrow band IF (100 Hz wide), S meter and headphone outputs, 50 dB AGC range and a built-in antenna capable of receiving stations up to 3000 miles away. The introductory price to readers quoting ETI with their order is £29.30 including UK post and packing. Contact Cambridge Kits, 45 Old School Lane, Milton, Cambridge CB4 4BS. Tel 01223 860150.

Radio Spectrum group set up by Government

Minister for Science, Energy and Industry John Battle has announced a new body, the Spectrum Management Advisory Group (SMAG), to advise Ministers on "strategic spectrum management issues" and play an important role in developing the application of spectrum pricing.

The SMAG will initially report to Barbara Roche, Minister responsible for the Radiocommunications Agency, who will also make appointments to the committee.

A summary of 60 responses to the consultative document "Implementing Spectrum Pricing", issued on May 29th this year, is available from the Radiocommunications Agency's library and information service (Tel. 0171 211 0500, fax 0171 211 0507), and with the responses in full from the Agency's Web site at http://www.open.gov.uk/radiocom/

ETI ELECTRONICS TODAY INTERNATIONAL News...

New P3 cordless mini power tool

The new cordless powertool from Minicraft is compact and useful for craft and household precision tasks. The Mini Power Tool can cut, polish, grind, engrave and drill in wood, plastic, ceramics, glass and light metals, runs at 9,500 rpm and has 25 interchangeable accessories to do the tasks. The new model P3 can run for 35 minutes between recharges, considerably longer than its MB1037 predecessor.

Another feature of the new model is the Minicraft 3-grip position with Pen Grip for close work and engraving, Palm Grip for sanding, cutting and carving, and Pistol Grip for drilling. The Mini Power Tool and its 25 accessories come in a sturdy plastic carrying case and includes an overnight plug-in charger and 12 months full guarantee.

For more information, a catalogue or list of stockists, call Minicraft on 07000 6464 27238.

Memory cards for use with digital cameras

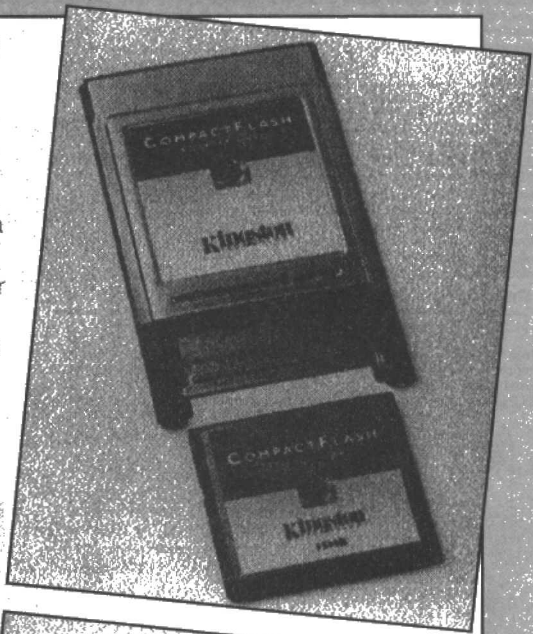
Memory maker Kingston Technology is launching two new data storage devices capable of use in, among other things, the current digital cameras from Kodak and Fuji. The Kodak Digital Science DC120 camera, the 15 MB CompactFlash memory card retails at £173, while for the Fuji DS-7 digital camera it is offering a 2 MB Solid State Floppy Disk Card (SSFDC) for £21. Optional PCMIA type II adapters for downloading the data to a computer for processing are available for the CompactFlash Card at £17, and the adapter for the SSFDC card at £73.

The Fuji DS-7 uses the new SSFDC technology, with its postage stamp-sized cards, for data storage. The makers offer a serial link cable to connect the camera and a computer for transfer of the stored data. With the help of the SSFDC adapter, it is possible to transfer data from the floppy disk card directly without a cable, to a computer equipped with a PC Card type II slot. The floppy disk cards can be inserted into the adapter and removed again while the computer is running, as with a standard disk drive. The adapter is fully compatible with Fuji hardware, software and diagnostics, and runs under Dos and Windows 3.1 and 3.11, Windows 95, Windows NT and OS/2, and supports plug and play under Windows 95 and Windows NT.

Kingston's CompactFlash memory cards, which are likewise fully compatible with the hardware, software and diagnostics for the Kodak DC25 and DC120 digital cameras, have robust design and fast data transfer rates of up to 8 MB per second. The PC card adapters for these memory cards permit rapid, convenient transfer of data to any computer with a PC Card type II slot. The CompactFlash products support Dos/Windows 3.1 and 3.111, Windows 95, Windows NT and OS/2.

The memory devices can also be used in personal organisers, pages, games consoles and portable computers, printers and scanners. Kingston also runs a free technical support hotline.

The CompactFlash and SSFDC memory cards and adapters are distributed in the UK by Datrontech, tel. 01256 360360, Ingram Micro, tel. 01908 260422 and Simms International, tel. 0181 877 7777. Further and information and a compatibility list for the FlashCard and digital cameras can be obtained from Kingston Technology, Kingston Court, Brooklands Close, Sunbury-on-Thames, Middx TW16 7EP. Tel. 01932 738813.



Book Reviews

DO IT YOURSELF ROBOTICS

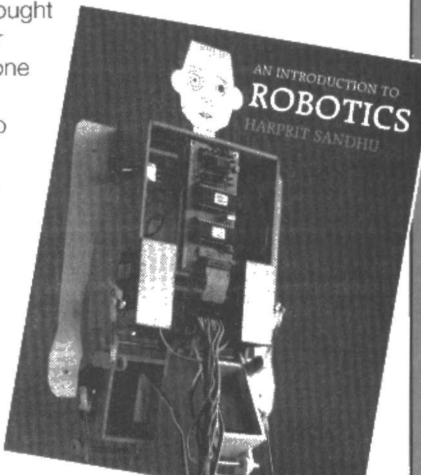
An Introduction to Robotics
Author: Harprit Sandhu
Publisher: Nexus Special Interests
Price: £9.95

This is a book covering the essentials of robotics, aimed at people who want to understand the technical details of how a robot can be made to function, but who may not necessarily wish to assemble one at present. Nevertheless, should you wish to assemble one, this book will help you do it.

The book starts with a brief view of ideas about robots in history, related to the technological developments required to make such robots a practical possibility. Considerable coverage is given to the software requirements, particularly robotic vision. At one point the author states that the software is the most important part of a robot, an opinion with which I would agree.

As a preliminary to addressing the general requirements for a robot, the author describes robots currently in use. Robot arms and automatically guided vehicles are the most widely used robots to date.

There are brief chapters covering motors, how to drive them (for example with pulse width modulation), and encoders to measure position. Chapter 7, about a third of the way through the book, pulls together all the requirements for a basic robot, while Chapter 8 covers the basic requirements of computer control. After that it gets rapidly more technical and detailed, dealing in turn with a software control code for robots, an vision systems. This section deals understandably with concepts sometimes thought complicated. The author explains what can be done without getting lost in mathematics, as can too easily happen when dealing with convolution and the like.



By half way through the book, the author is dealing with the assembly of a robot intended to be straightforward enough for most diy constructors to build, and good enough to illustrate some of the problems and solutions for controlling a robot. The last section of the book deals with programming the robot, making it move and walk using a programming code designed for the purpose.

Appendices include a glossary and ascii table, information on a PIC based controller for robots, assembly drawings, and other necessaries.

If you are interested in robotics, and particularly if you would like to do some practical experiments, then you may find that, with the aid of this book, you can reach the stage of having something to experiment with rapidly and efficiently.

SURFACE MOUNT FOR EVERYONE

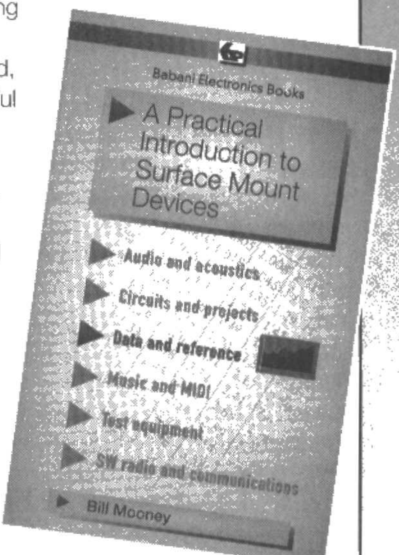
A Practical Introduction to Surface Mount Devices
Author: Bill Mooney
Publisher: Babani Electronics Books
Price: £4.99

Modern electronic equipment is more likely to be made with surface mount components than with conventional through-hole ones nowadays. A major reason is to make consumer items smaller, but in addition assembly by automatic component placement and infra red reflow soldering can be cheaper than the through hole alternative.

One consequence of this is that a number of useful component devices are only made in surface mount packages, and through-hole equivalents are not always introduced. Increasingly, in the future, it will become useful for the home constructor to be able to handle surface mount components.

Here is a book which aims to show the home constructor how to make practical use of surface mount techniques, without the need for the methods used in industry. Industrial techniques use very expensive tools, such as infra red reflow equipment, and have high setup costs but low cost per unit manufactured. This is the exact reverse of the normal amateur constructor's requirement.

This book covers prototyping, which is possible using smds, as well as design of pcbs for home manufacture. The different approach to design and etching necessary for surface mount pcbs is perfectly well explained, as are the specialist tools useful for the task.



Size codes for surface mount passives are explained, both in metric and the currently more normal imperial terms.

There are a couple of sample constructional projects - one for an audio amplifier, and one for a live wire detector, both useful modules.

The techniques and tools covered here should give a better result than techniques I have found just good enough for surface mount prototyping. Author Bill Mooney is an smd designer and constructor with long experience of small-scale prototyping and building, and knows the problems and pleasures well. Follow the guidelines in this little book, and you should have consistent success with surface mount assembly.

Digital Cameras - Coming of Age?

Now that digital cameras are within reach of the ordinary photographer, Douglas Clarkson believes that the secret of their popularity will be in the versatile output that data capture and home printing offer to users.

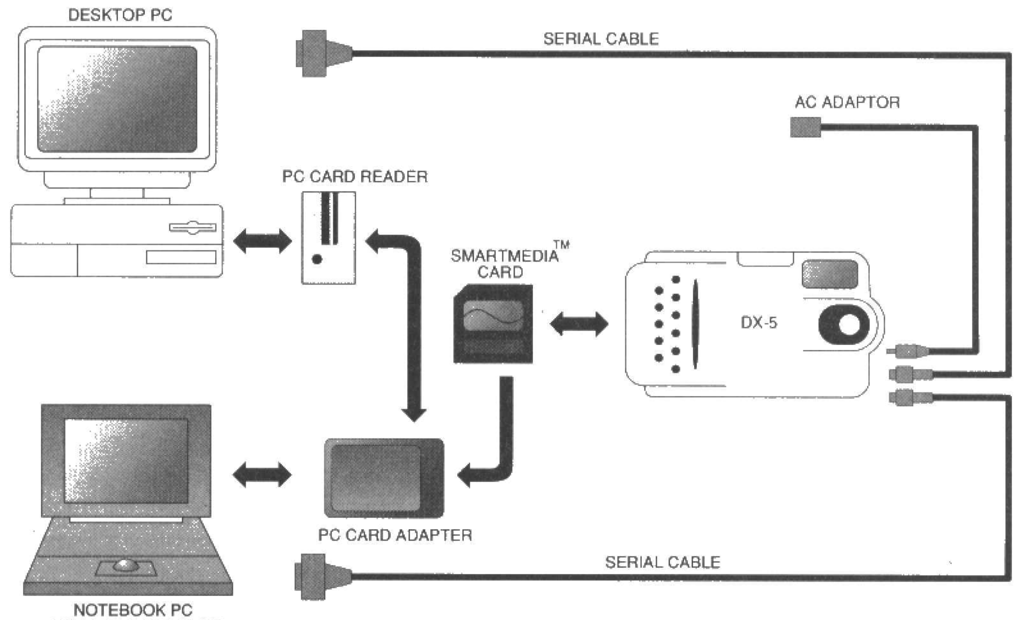


Figure 1: Basic configuration options of the DX-5

To delve into the field of emergent digital camera technology is to become aware of another tidal wave of technology being offered to us. This in itself may make the buyer beware, because, in a game with many keen players, product lifetimes are likely to be relatively short, at least at first.

While the technology of digital cameras is fascinating, an analysis of the emergence of digital cameras has more to do with understanding the integrated use of such systems than their technology alone. As the Internet expands at breakneck speed, the process of capturing images, processing and incorporating them into web sites has been fundamentally altered. Suddenly the process of conventional film developing and print/transparency/negative scanning for digital use appears slow and outdated.

Where images can be captured digitally and transferred directly and quickly to perconal computers at an acceptable quality of resolution, this is likely to become the method of choice.

In the media, newspapers from the locals to the nationals are issuing staff photographers with professional digital cameras, so that only minutes after that vital front page image is captured hundreds or even thousands of miles away, it can be incorporated into page-making software. It is the immediacy of the digital age that is leading to the use of digital cameras - where resolution and quality permit.

The uptake of digital cameras by professional photographers doing studio work tends to be determined by the resolution required. Where print sizes are relatively small, such as for catalogues, professional digital cameras provide a convenient means of rapid capture and review of images. Where the image is needed for a large glossy magazine cover, only top of the range digital cameras with a matching price tag will suffice.

It is obvious, however, that digital cameras are beginning to take off now that the cheapest are below the £200 mark. The most expensive digital cameras hover at around the £40,000 mark. It is also obvious that the very newness of the technology, and the various means of linking digital cameras to systems to process the data, can be confusing for the newcomer.

The appearance of digital camera technology is itself an indication of the maturity of a much broader marketplace in the technology that makes such systems viable. The whole field of exchangeable smart card media which simplifies the process of readout from digital cameras is itself a mushrooming processing. Advances in this field were introduced by the Kodak Photo CD technology using the standard image resolutions listed in Table 2.

Image resolution	Data size
128 x 192	72 k
256 x 384	288 k
512 x 768	1.1 Mb
1024 x 3072	18 Mb

Table 2: Standard image resolution of PhotoCD

This was the first step to providing cheap, high quality scanning to the general public. For 35 mm work the cost per image is around 60 p and up to 100 images can be stored on each disk.

This development has established CDs as a useful medium for distribution of 'stock' images for media industries such as advertising. Companies such as DigitalVision make available a wide range of royalty-free digital stock photography.

35 mm positives or negatives or film transparencies can typically be scanned over a range of densities. At the high end, the Polaroid Sprint Scan 35 Plus can scan up to 2700 dpi with the 35/LE model processing a very adequate 1950 dpi. The cost of 35 mm desktop film scanners has come down dramatically in the last 18 months, with systems costing now between £400 and £750 plus VAT. Entry level desktop scanners cost around £100.

Scanners tend to use a single-pass system, where a line of pixels has a separate colour filter. Colour data tends to be stored in 8, 10 and 12 bits, though display arrays usually handle only 8 bits per separate colour.

The Kaiser company of conventional photoenlarging fame has introduced a camera scanner for capturing digital images with 9.7 million pixel resolution, achieved by moving a scanning head with linear CCDs across the image plane. Such a process can only be used to capture images that are completely static.

With the wide range of products on the market, it is now quite possible for individuals to scan their existing 'conventional film' photographic library and store the images in data bases on PCs or MACs.

DVD

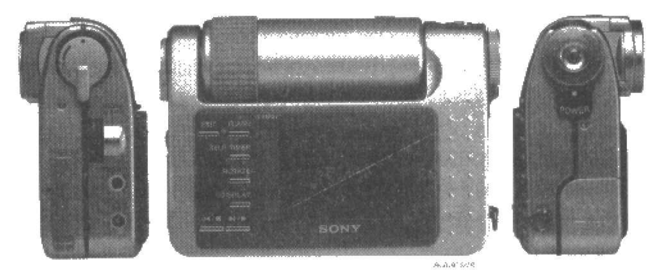
While Compact Disc has emerged as a useful storage media for Kodak's PhotoCD system and others like it, Digital Versatile Disk (DVD) could provide a significantly higher storage capacity of around 7.46 GB, initially on single sided disks, with a possible extension to 17.6 GB on double sided disks in the future. It is possible that in a few years' time dual CD ROM/DVD drives will allow CD-rom and DVD disks to be read by one format. As image quality increases, DVD systems could be a useful means of distribution of high quality images.

Post processing

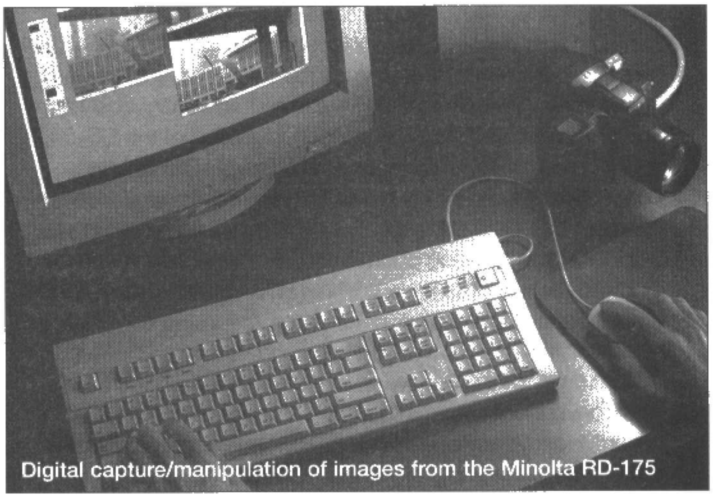
Digital camera enthusiasts are replacing the spills and chills of the damp darkroom with the subtle mousework of a PC. In the broadest context, PCs and MAC photo-production and photo-editing systems can be seen as an evolution that is almost as significant as the introduction of photography itself. In the context of photography itself, however, the emphasis will be on taking care of the image once it has been captured, or shooting the same shot many times and recycling the storage space spend on unsatisfactory images - not possible with conventional film. Conventional photography aims to get the image correct as close to first time as possible, with all the relevant application of knowledge of light, field of view, depth of focus, aperture and so on.

There is always the risk that the techniques of post processing, such as red eye elimination, opening the bride'e eyes if she blinks as the wrong moment, sharpening up out of focus lines, and so on, could become, in the wrong hands, just a makeshift means of 'correcting' poor photography.

Part of the appeal of digital cameras is the degree of control that the photographer has in processing images. In post processing, where image size is increased, different types of interpolation of images, such as nearest neighbour, bilinear and bicubic, are possible. In nearest neighbour, additional pixels are added at the level corresponding to neighbouring pixels, while in bilinear, a linear correspondence of changing values is made between neighbouring pixels. In bicubic interpolation, more complex level-finding is achieved by using data from a range of nearest neighbour pixels.



Views of the popular Sony DSC-F1



Digital capture/manipulation of images from the Minolta RD-175

Advances in CCD technology

Noise in digital cameras can appear as pixels of the wrong colour appearing at random in dark areas. Under ambient dark conditions, a CCD array will produce an average background level of noise. A 'black' reference is typically stored in a given camera system to allow subtraction. One of the quality factors of a digital camera specification would be the level and variation in noise levels.

In seeking to make still camera chips ever smaller, the problem of reading the output of smaller charges leads to the introduction of extra unwanted signal noise. Systems such as Canon's Basic Stored Image Sensor (BASIS) are seeking to amplify signals using individual pixel amplifiers to overcome this problem.

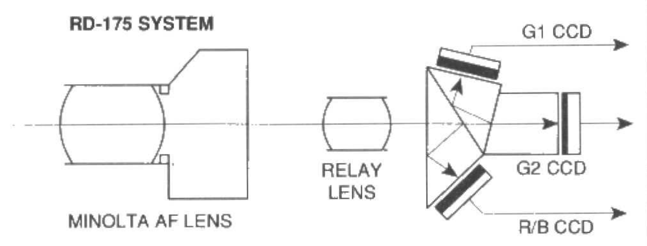


Figure 4: Three CCD image system of the Minolta RD-175 in order to achieve higher resolution

The considerably more advanced DS-300 has a 2/3 inch CCD with 1.4 million pixels, the same chip that is used in the top-of-the-range DS505/515A SLR-type digital cameras. The effective array size is 1280 x 1000 pixels, which is roughly twice the resolution (four times the pixels) of the standard 640 x 480 pixels of VGA resolution. An increasing amount of connectivity and interaction is available with this model, as outlined in figure 2. The DS-300 won the Best Digital Camera 1997/8 presented by the Technical Image Press Association (TIPA).

Still further up the ladder lies the Digital/SLR types, DS-505A and DS-515A, with the DS-515A continuous exposure model costing over £10,000. The keynote of the DS range is the use of condenser optics to increase light levels at the CCD to increase the apparent speed of the system to ISO 3200. This extends the usefulness of the camera to areas such as sport where up till now digital cameras were too slow to capture rapid events. The higher specification of the DS-515A provides a series of three frames per second in a series of seven shots, while the DS505A can record continuously at one frame per second. The condenser optics of the DS-505A and DS-515A are demonstrated in figure 3. The design concentrates the light on the CCD using specialised lens focusing optics. The sensitivity of CCDs will no doubt increase with research, allowing shorter and shorter exposure times. Compression of data is usually in JPEG form, with a variable amount of compression.

Memory cards

The conventional means of image storage can be by SmartMedia with PC adaptor, or ATA type I or II PC Card (PCM CIA release 2.1). A 10 MB Fujix memory card is supplied with the system, which can in turn accommodate four high resolution TIFF images and 16 'fine' (JPEG) images.

As an option, a SCSI extension unit can be added to connect to a PC SCSI port for high speed data transfer. The PC in this mode can also act to control the camera, effectively making the camera into a computer peripheral.

The SCSI interface allows direct output to a digital colour printer such as a Fujifilm Digital Colour Printer NC-500 or Pictography 3000. In addition, the NTSC/PAL video interface allows viewing of these images remotely.

The memory cards, however, are relatively expensive. With the current price of the DS-300 at over £2000, this is at present the domain of the very dedicated photographer.

In the present state of digital camera development it is more or less essential that the user has access to a PC or Mac to process the data through data transfer. The day may come when a SmartMedia card can be inserted into a specialised photo developing booth, and you can select which images are to be printed and in what format. Already, colour printers for the dedicated amateur are on the market which will print directly from a digital camera. The required high definition that is often required, however, is at present only abailable on professional systems available at a few selected sites.

On another front, Sony have resurrected the floppy disc as a means of data storage. One 3.5-in 2HD floppy used in the Mavica MCV-FDS and MCV-FD7 can store 20 high resolution and up to 40 standard resolution images.

Unusual features

Searching around will locate digital cameras with unusual assets. The Dimage V by Minolta has many of the standard features - a 1.8-in colour LCD monitor, 680 x 480 pixel sensitivity, and so on, but has a novel lens that can be rotated and is detachable from the main camera body. This incorporates a 2.7 x zoom lens, and the camera costs around £599.99. Minolta have identified a number of interesting applications for the system, such as business card databases, pictorial information files for property or vehicles for sale, or other catalogues that benefit from pictures, making greetings cards and creating Internet pages.

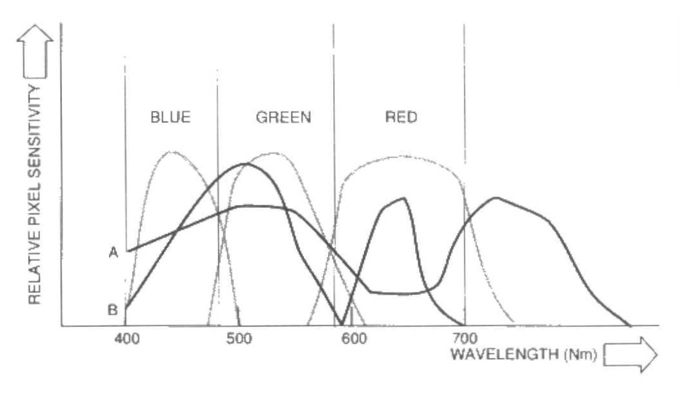


Figure 5: Colour sensitivity of RGB filters is important for rendering faithful colour rendition of, for example, two light spectra A and B

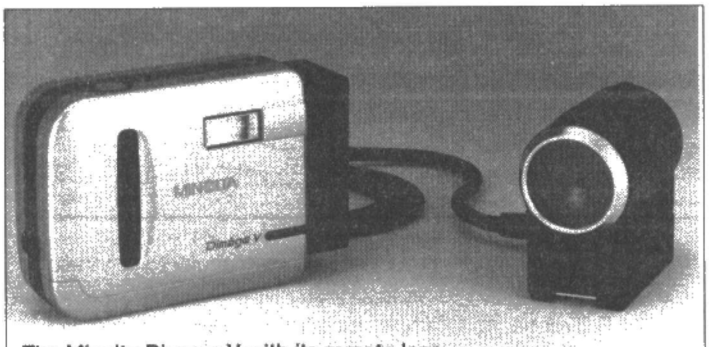
As the number of pixels in the CCD increases, the cost of the CCD rises sharply. The Minolta RD-175 uses a clever mechanism (figure 4) where three separate 380,000 pixel arrays incorporate colour filters and are diagonally shifted to 'fill in' any gaps in the image plane. The final effective resolution achieved is 1528 x 1146 pixels. Data storage is achieved with 131 MB which can record 114 image frames. This design shows considerable ingenuity and its success requires the relative registration of the CCDs to remain fixed and absolute.

User view of Fuji DS7

Multiple exposure CCDs

Among the most advanced CCD chip technology is the 2048 x 2048 pixel chip manufactured by Loral Fairchild. This device has been used in cameras intended for professional use. The technology of these cameras can capture either through multi-exposure technique where red, green and blue filters are used for separate exposures or, alternatively, via a single exposure with a mosaic filter placed over the CCD with each pixel generating a red, green or blue signal during one exposure. An interpolation algorithm produces an RGB data file using localised pixel values.

In a commercial environment, the ability to capture images, verify them quickly and print them locally saves time, so that after a day's shooting hundreds of images can be captured and transmitted to a client for comment and review on the same day. Depending on the quality of the phone lines, distance should be no object. In commercial photography, sharpness of focus in the field of view is an absolute key factor. With conventional film, this is typically improved by narrowing down the diameter of the lens iris and using fast film. With digital cameras, normally using multiple exposure, this requires high levels of either tungsten or flash illumination. It can take flash units of the order of 3000 Joules per pulse, and tungsten units with a power rating of 4 kW to give enough illumination.



The Minolta Dimage V with its remote lens

View of Minolta DS-175 which uses three separate CCD arrays to obtain higher image resolution

Rather than invent a wholly new digital camera, independent companies have developed so-called Digital Camera Backs for existing high-quality cameras such as Hasselblad. Camera chips in general offer a smaller field of view compared with conventional film. This can be a complication with studio camera systems using 'Camera backs' with front optics designed for conventional film.

Printers

A range of colour printers developed originally to meet the demand for printing of computer originated/processed images using modern graphics packages, can now be used with digital camera technology if you have the correct format and software.

To recap, Inkjet printers are low cost and usually reliable, but the fibrous nature of standard printing paper tends to blur the edges of dots so that edges appear softer and colours appear weaker. Specialist inkjet papers, however, can make a startling difference to print quality.

Colour laser printers work typically with four separate toners, cyan, magenta, yellow and black (CMYK). Each toner is separately mapped onto the final printing surface by electrostatic charge buildup on a photoelectric belt. In the final stage, the toners are heat fixed on to the paper surface. While output is fast and needs no special paper, the final quality is good but not considered to be photographic quality. Dye sublimation printers operate by moving a plastic dye ribbon under a series of print heads which can be accurately heated to varying degrees. This results in dye from the ribbon being sublimated onto the paper surface, providing fine definition copy. Full size A3/A4 printers are expensive, but small printers such as the Fargo FotoFUN are now appearing on the market for around £400.

While the printing needs of amateur photographers are fairly modest, the developments in mainstream digital colour printing are quite staggering. Various companies are now offering a data download/digital print service. The FotoNet service provided by Fujifilm in the UK allows digital images to be printed on state-of-the-art printer Pictography 3000 at 400 dpi. A choice of one, two or four images can be printed on each A4 sheet.

Printing techniques can typically give 300 dpi for high resolution colour printing on A4 to A0 sheets and with lengths up to 59 feet. It is even possible, in theory, to design your own wallpaper and have it manufactured in this way. This kind of design will see great change in the next few years. The designer can be anywhere, and the means of final production can be anywhere, and the market for such goods and services can be everywhere.

Fabric printing

The interest in digital photography is growing because the image can printed in so many forms. Among others, interior decorators should take note. Using the technique of specialised dye sublimation printing onto fabrics, photo-quality colour images can be printed at an incredible 400 dots per inch; a lot more than you get on your souvenir t-shirt. This printing is durable, fully washable and can be ironed. (Although many of us will think it is better progress when ironing is not needed!) In the UK, a company called CPL provide a range of services from eight locations (see points of contact, below). So the new path of fabric production could be artwork, digital camera, PC image processing and dye sublimation printing. It will be interesting to see how the uptake of this kind of process interacts with conventional fabric print technology. There are abundant market opportunities for designer fabrics and designer clothes.

Scanners

Don't throw away your prints, negatives or transparencies. These conventional media with their intrinsically high analogue resolution will continue to be used for high quality digital image

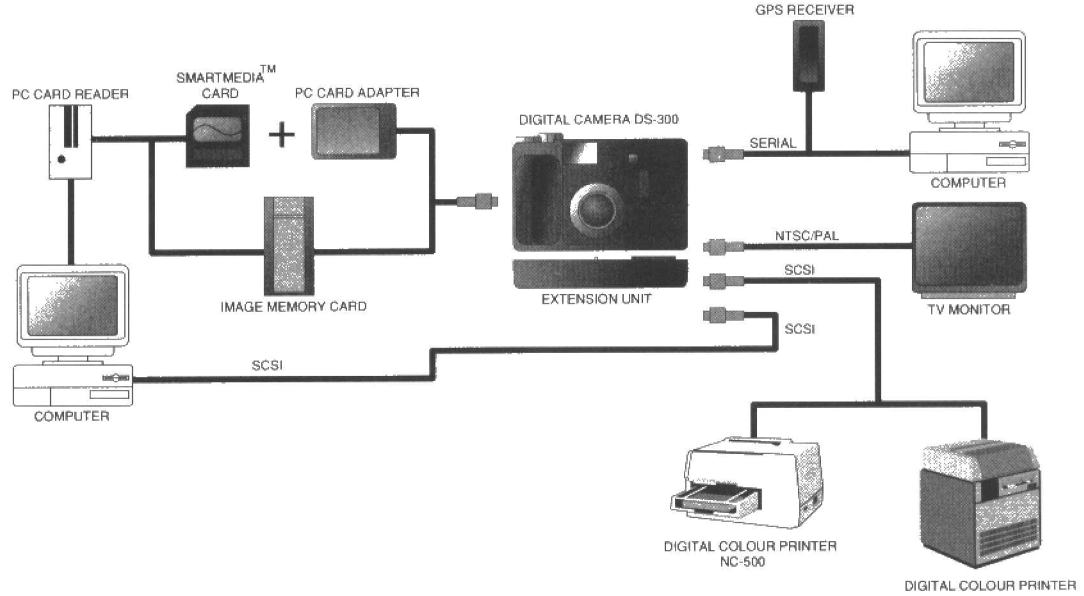


Figure 2: Connectivity of the Fuji DS-300 digital camera

industry which is shaping other areas such as mobile phone technology. Colour print systems are being developed to provide low cost and acceptable print quality directly from digital data. So digital photography has a complex interaction with a rapidly expanding product base in other areas.

The Internet is already providing one means of distributing digital images, so that before long millions of useful images will be available over the Internet. It remains to be seen, however, how great the demand for such images will be. The real market for professional photography is probably the day by day need for specific studio work.

MediaCards

In a curious twist of technology, SmartMedia Cards have been incorporated into a 3.5-inch floppy disk adaptor that can be inserted into a PC floppy disk drive. This is also being used in parallel developments such as personal security and access systems for home banking developed by Fischer International Systems. When the "lookalike" floppy disk is inserted into the disk drive it "tricks" the PC into believing that it is reading a normal floppy disk.

SCSI

The Small Computer System Interface (SCSI) has found ready application in routing data between digital cameras and computers. The first version of SCSI provided a transfer rate of 5 megabytes per second over an 8-bit bus. Table 1 shows how various enhancements of the initial standards have provided increasing performance.

Mode Transfer Rate	M bytes/sec
Original SCSI	5
Fast SCSI	10
Ultra SCSI	20
Ultra 2 SCSI	40

Table 1: Developments of Transfer rate of SCSI implementations.

The product spectrum

There are probably now over 100 digital cameras on the market, with new models announced daily. It is interesting to look across a range of products from one manufacturer to see the stages from basic to professional grade.

The Fuji range, for example, runs from the DX-5, which meets the need of the basic digital photographer, to the top of the range FUJIXC-DS-515A. Figure 1 shows the basic configuration options of the DX-5. The DX-5 is a typical entry level digital camera with the VGA resolution of 640 x 480. Data is stored in a SmartMedia Card which can be read by the PC card reader of a desktop PC, or the a PC card adaptor of a Notebook PC with a PC card slot. A serial cable also provides connectivity for PC capture and processing of data. The cable connected is a MiniDIN 9 pin for the serial interface. The basic model has a viewfinder and flash but no LCD monitor. With a 350,000 square pixel array in standard VGA 640 x 480 form, a 2 MB SmartMedia Card will store around 30 normal images and 22 'fine' images. The sensitivity of the device is equivalent to ISO 150 and shutter speeds are available between 1/4 and 1/5000 of a second.

The next member of the family, the DS-7, incorporates a 1.8-inch active matrix colour LCD as an aid to picture composition and browsing captured images. In the "live imaging" mode the screen updates at 60 frames per second using the CCD array directly. Images once recorded can also be played back immediately, providing the option to delete any that are not required. The LCD display is therefore a considerable move on from the basic glass viewfinder. At the same time, it does not give the direct one-to-one viewing of an SLR camera.

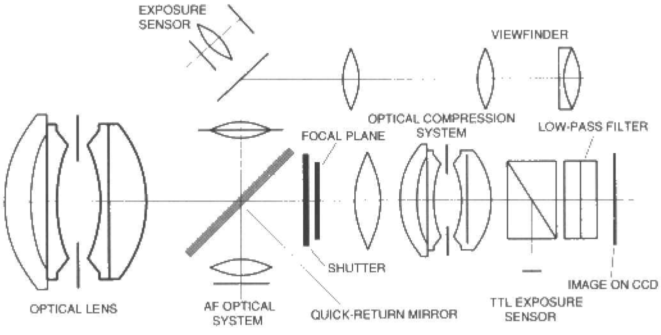
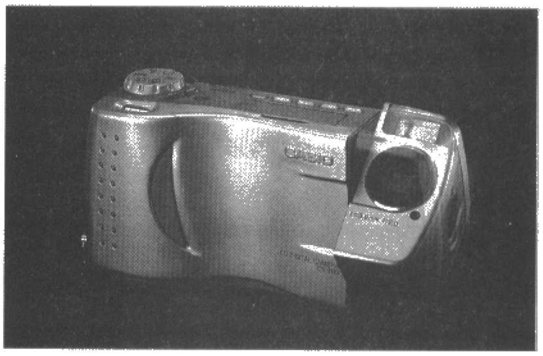


Figure 3: Condenser optics of the DS-505A and DS-515A which increases light intensity in the plane of the CCDs

A growing digital family - some with software included



The new Casio top of the range consumer QV-700 has a rotatable lens and uses removable Flash Memory cards (see other photo) that can be plugged directly into an appropriate PC slot.

The first company to introduce low-cost digital cameras was Casio, already well known for personal organisers and calculators. Examples of two ends of their range are the "entry level" QV-11, costing just under £300, which replaced their basic QV-10 earlier this year, with a reputation for good close-up focusing and ease of use. The viewfinder/ monitor consists of the 1.8-in TFT colour LCD, and the camera can store 96 images in 2 megabytes of Flash memory. The lens has a fixed focal length with a Macro position, and the CCD is 1/5 inch. PC Windows and Macintosh connection kits (software and cable) and video cable are accessories.

The £400 QV-200 has built-in special effects with 4MB internal flash memory and JPEG-based digital storage of up to 192 images in "normal" mode or 64 images in the higher-resolution "fine" mode. The CCD is 1 / 4-in with 360,000 pixels, and again the 1.8-in backlit colour LCD doubles as the viewfinder. The lens block rotates through +90 to -180 degrees, with -90 to -180 degrees for reversed images. The QV200 has a facility for camera-to-camera image data transfer between Casio cameras with an optional cable at data output resolution (fine) of 640 x 480 (VGA). The Fine images can be converted to the Normal images to expand remaining memory. Images can be automatically scrolled through for auto-demonstration, VCR recording, and so on and individual unwanted images can be deleted after verifying on the display. Software included in the UK is QV-Link, Spin/Panorama and AOL Internet connection.

The very new QV-700 checks in at around £500 and as well as a 2.5-in LCD screen - the largest size found in popular models - the QV-700 uses removable Flash Memory cards that can be plugged directly into a PC slot. It is also one of the generation that has internal image manipulation software, so that the user can do certain things without even plugging into a PC: convert an image to black and white, add labels or store in one of six named files for easier location. Software includes QV Link, Spin/Panorama for linking separate images into a single image (the our front cover) and before Christmas 1997 50 hours of free AOL Internet operation.

Lastly for Christmas - the new £330 QV-70 is a lightweight digital camera that has an optical viewfinder as well as the Casio LCD monitor. This is an interesting departure as the presence of an optical viewfinder saves battery life when the LCD is not in use, and is considered an advantage by many photographers.

While one basic limitation of CCDs is the inherent resolution, the other is that of the inherent sensitivity. Most digital cameras correspond to a film speed of ISO 150 - equivalent to a fairly slow but high resolution film. The use of micro lenses above the CCD array can concentrate light and bypass the sensitivity of the device accordingly. Most advances, however, are likely to come from improving the inherent sensitivity of each CCD element.

The information gaps

I found some gaps in the technical descriptions of standard resolution digital cameras. While the 640 x 480 resolution is quoted as applying to the three colours red/green/blue, this is not explicitly described as being obtained by means of a mosaic of RGB filters over the pixel array and with interpolation of colours as appropriate by software within the camera. It is only with 'single shot' mode, higher resolution studio cameras that this method is described in detail.

Also, the spatial design of the RGB mask must have a bearing on image quality, although these design aspects are not usually discussed in the companies' descriptive literature.

A critical part of digital camera image quality is the spectral response of each filter in the RGB mosaic filter. Figure 5 illustrates the general principle of the way an RGB filter represents colour. The spectral components of a given part of the light spectrum are separated using the various filters. Variations as part of this include the absolute spectral response of each pixel acting as a discrete detector and also the degree of uniformity of this response amongst all of the pixel components of the array.

It is quite possible for curves A and B to give the same sensitivity signal for each pixel detecting Red/Green/Blue, though they are not in fact the same colours. The quality of colour rendition is determined by the 'sharpness' of the transmission profile of each pixel. Clearly there is an effect here of the basic sensitivity of the human eye to colour - that is, how much it can of itself differentiate different colours. There is much in the way of absolute measurement that can be undertaken to identify absolute colour rendition, though such measurement techniques appear not to be over-used in photographic evaluation of digital cameras. Colour is generally described as either 'lifelike', 'dull', 'vibrant' or 'flat'.

There are even subjective claims that digital camera colour is better than film colour. Film has its own colour mapping, with colour film and CCD behaving slightly differently. Some observant professionals even indicate that CCDs can detect colour which film cannot detect. Also, some aspects of film processing can degrade the image - for instance, by scratching and nonhomogeneity in the film substrate. Again, however, there is very little 'absolute' measurement of colour quality to allow a true comparison to be made.

Business focus

It is not enough, however, to focus on the cameras alone when assessing digital photography. There are a whole range of applications that could benefit. Surveyors, builders, mobile engineers and service personnel often need to send data from the field to headquarters for verification and consultation. This can lead to shorter decision times and greater efficiency. Companies seem to be interested in maintaining image databases of staff and visitors, both for production of ID cards and for storage for longer term security.

House buying could begin in the future as an inspection of thumbnail images on the home page of an estate agent, including pcitures of rooms and perhaps the new conservatory. A lot of shopping is visual: wallpaper, curtains, tiles, jewellery, some clothing and so on. The biggest experiment in cyber shopping will probably unfold as individuals get fast access to digital images of thousands of products.

Learning the facts

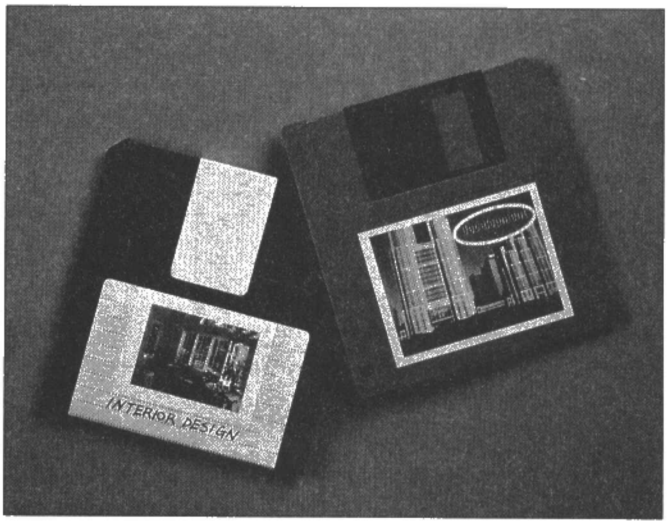
There are any number of monthly publications that review and compare digital cameras with each other and with a variety of standards, including the quality of 35 mm colour film photography. The feeling is still that digital cameras will never be as good as 35 mm film, except, perhaps, in the very top of the range models. Publications like Electronic Imaging provides a more distanced view on digital camera technology, devoting more time to professional studio photographers whose digital camera is usually worth more than their R reg company car. In high street retail outlets, the correct and informative way to demonstrate digital cameras would be data links to a PC, but you would be lucky to find such a demonstration at the moment. But without the link-up, digital photography loses much of its advantages.

Internet links

The Internet supports many pages dedicated to camera technology. Table 3 provides some main addresses that can be used a starting points for information about digital cameras. This is particularly relevant if images which have been taken using a specific digital camera can be inspected.

Company	Address
Agfa	http://www.agfahome.com
Apple	http://www.apple.com
Canon	http://www.canon.com
Casio	http://www.casio.com
Epson	http://www.epson.com
Fuji	http://home.fujifilm.com
Kodak	http://www.kodak.com
Nikon	http://www.klt.co.jp/Nikon
Olympus	http://www.olympusamerica.com/digital/dhome.html
Polaroid	http://www.polaroid.com/digiworld/index.html
Ricoh	http://www.ricoh.com
Sanyo	http://www.sanyo.co.uk
Sony	http://www.sony.com

Table 3: Some useful Internet addresses.



Two pictorial disk labels made up with with the use of digital photo editing and a printer. Useful diy home-and-workshop items like this are one of the attractions of digital camera systems.

A last word

The key to digital photography at present is the inherent resolution of the CCD devices. For on screen inspection of standard resolution images, many basic 680 x 480 resolution systems provide acceptable image quality. The gap between conventional film and digital prints becomes clear when prints are produced at standard sizes.

Basic resolution digital cameras provide, however, excellent opportunity for practical applications that depend on the rapid capture and transmission of images. For many applications, basic digital cameras are already good enough to be used seriously. Cameras with improved resolution give a comfortable margin of image quality in many cases. At the high end of the market, digital cameras are increasingly used to capture high quality images with the advantage of fast turnaround.

For now, if you wish to make a collection of ultra high resolution images capable of being blown up to large sizes, a good 35 mm camera and film is still the cost-effective route. Negatives or transparencies scanned with good quality equipment can be archived digitally with their inherent resolution preserved.

Grasping the full potential of digital cameras is about seeing the scope for applications in the future.

Points of contact

Digital Vision Ltd., Chelsea Reach, 79-89 Lots Road, London
SW10 0RN.
tel 0171 351 5542 fax 0171 351 6487
web http://www.digitalvision.ltd.uk

CPL (Fabric Printing)
tel 01732 862555
web http://www.cplnet.co.uk

Electronic Imaging, Market Link Publishing, The Mill,
Bearwalden Business Park, Wenden's Ambo, Essex CB11 4JX.
tel 01799 544212.

Photo credits

Photographs courtesy of Casio UK, Minolta UK, Sony UK and Fujifilm UK as appropriate. Thanks particularly to Casio for assistance with cover images.

4-Go Rocket Launcher

Fire up your ingenuity! For the more ambitious rocket modeller, Robin Abbott has made a four-rocket launch controller to work with popular rocket kits.

This project was inspired by my interest in model rocket building. Model rockets made up from kits are available in a wide variety of sizes and configurations from small 6-inch rockets up to 4 feet or more. The rockets are launched with a small cartridge engine which is electrically fired. Model rocketry company Estes provide a simple kit which includes a controller. The controller is a very simple 6V powered unit with a safety key, a launch button, a small bulb which illuminates to indicate that the igniter is connected, and 8 metres of cable to connect to the rocket. The connection to the igniter is made with crocodile clips. The controller does not fire more than one rocket, or fire rockets with more than one engine cartridge, so for more ambitious modellers this project was devised to provide a more comprehensive controller.

Rocket Modelling

Model rocket flying in the UK is dominated at the less ambitious end of the market by the Estes company of America. Estes manufacture the rocket cartridge engines, igniters and kits for the rockets which are available from large model shops. The home constructor cannot manufacture engines or igniters, but the rockets are quite straightforward to construct with or without a kit.

Most rockets are made of two stages (see figure 1). The stages slot into each other at the launch and are connected by a length of elastic cord. The upper stage has a simple plastic parachute tied to it, the lower stage has the fins for stability. The lower stage has a simple engine cartridge holder with a metal clip which allows engines to be replaced easily and to allow the rocket to be fired a number of times. On firing, a new rocket engine cartridge is inserted into the holder, and fireproof parachute wadding is pushed into the rocket. The parachute is folded and tucked in below the top stage of the rocket which is plugged into the lower stage.

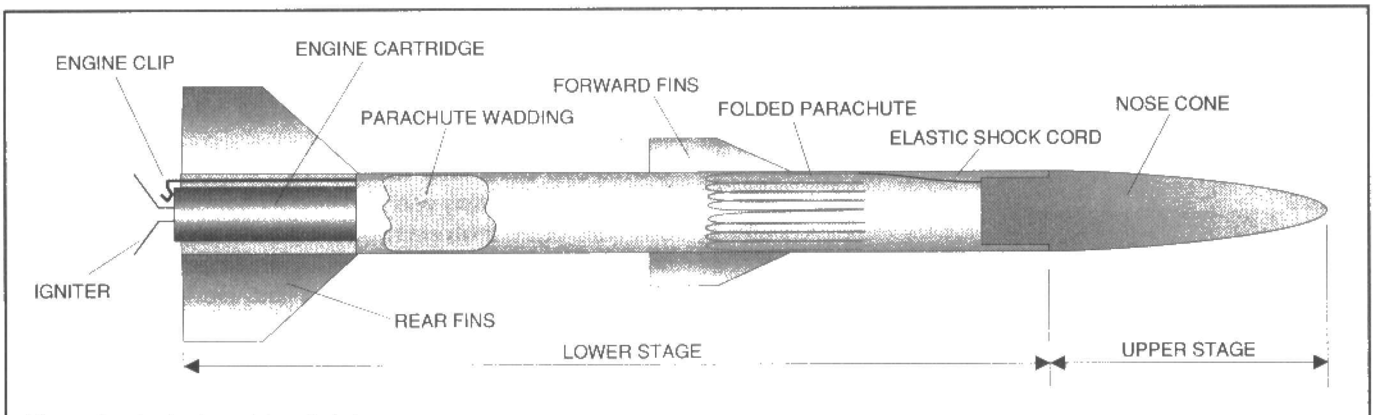


Figure 1: a typical model rocket

The rocket has a small length of drinking straw glued vertically to its side. This is slotted over the "launch pad" which is a length of piano wire held vertically in at stand with a metal blast plate at the bottom. The igniter is pushed into the engine cartridge, and held in place with a small rubber stopper. At this point the launch controller may be clipped to the igniter, ensuring that the safety key is held by the rocket operator so that the controller cannot fire the engine while it is being connected.

When the engine fires, the igniter is connected to its power supply. The igniter has a resistance of around 1.2 ohms and is surrounded by a chemical similar to a match head which lights due to the heat of the igniter. The igniter then lights the rocket engine which fires pushing the igniter plug out of the engine and the rocket lifts off to height which may exceed several hundred metres when small rockets are fired with larger engines.

The cartridge engine is a three stage system. The first stage is the power stage which lifts the rocket to the majority of its final height and speed. Next the engine continues with a delay stage which has considerably less thrust, but shows its presence with a plume of smoke following the rocket. During this stage the rocket normally has enough speed from the first stage to continue climbing vertically. Without this delay the whole flight seems very short. Finally the ejection charge fires. This pushes a jet of gas out of the back of the engine into the body of the rocket. This pushes out the parachute wadding (hence the need for fireproof wadding), and the top of the rocket pops off, the parachute opens, and the rocket floats gently to earth. It may then be recovered and fired again.

Types of rocket

There are many different types of rocket available, and they are identified by three parameters: for example, A8-3, or D10-2.

The first is the engine power - A, B, C, and D. The letter represents the total power of the engine: each letter is twice the power of the one before it. Thus B engines have twice the total power of A engines and D engines have 8 times the total power of A engines. A engines are small, B and C engines are both medium size (70mm long by 18mm diameter), D engines are bigger again.

Each engine has a thrust number in Newtons, so an A4 engine will have a thrust of 8 Newtons, and will burn for half as long as a B4 engine, and for the same length of time as a B8 engine.

The final parameter associated with the engine is the delay time in seconds, this is the time taken between the end of the first stage, and the ejection charge firing during which smoke is ejected.

Thus for our example the engine has a total power rating of A, a thrust of 8 Newtons, and a cruising delay time of 3 seconds. Typically B and C rocket engines cost about £1.50 per flight.

In general bigger rockets require bigger engines and higher thrusts. Thus a small rocket will fly higher as the thrust may be lower, will take it higher, and will burn longer. Also bigger rockets will cruise for less time before they turn over and start heading earthwards, so the delay time should be shorter in general.

A rocket leaves the launch site Photos courtesy of Sven Knudson

The launcher

This launcher provides for firing of up to four rocket engines. There are four firing modes:

- All four rockets may be fired simultaneously when the firing button is pressed (allowing for more than one engine on a single rocket). The launcher detects when rocket igniters are connected by the low resistance (approximately 1 ohm) of the igniters, and shows the status of each rocket on its own LED.
- Rockets may be fired in sequence, the next rocket being fired each time that the firing button is pressed.
- Rockets may be fired automatically at one second intervals in sequence.
- One or more rockets may be fired at the end of a traditional 10 second count down.

The firing pulse given to the rocket is limited in duration to 3 seconds. This means that even if a rocket connection is shorted out, the batteries will not be rapidly drained - a common problem on the launchers, where accidentally shorted crocodile clips can drain the batteries through the igniter detection lamp.

If PC control is added it allows specialist applications (note that hardware is included for PC control, but the software is not yet developed).

Safety

Safety in a project such as this is of great importance, and the project provides a number of safety features. The intention is that any single failure should not cause the rocket to fire while the operator is connecting the rockets, and to this end the following features are provided:

There is a single safety key. This connects power to the relay switches, and is also used by the firing logic to disable the firing button when it is not present. Once the launcher detects that a rocket has been connected, the fire button is disabled for 3 seconds afterwards regardless of the presence of the safety key. This allows operators to get away even if the safety ke y is connected.
The launcher will only fire the rockets detected when the firing sequence was started. For example with a 10 second count down, then once it has started even if additional rockets are connected during the countdown they will not be fired.

The project may also be used for firing other electrically ignited devices such as fireworks or thunderflashes, provided that they operate on a supply of 24V or less.

Controls and the launcher

The launcher is battery operated, and for reasons which will be described below there are two sets of batteries, one for the controller, and one for the igniters. The batteries should be alkaline, and should last an very long time, provided that the unit is turned off after use.

There are two switches on the launcher which control the operation of the launcher. There is a 2-digit 7-segment display, and four LEDs, one for each rocket to show when the rocket is connected. There is a connection for a PC input, which connects directly to another socket which may be used to chain launchers. From the back of the launcher there are four 8-metre cables with crocodile clips, one for each rocket. As the safety key is inserted directly into the launcher, the launcher should be located with the operator, and not with the rockets. The firing button is on a short cable connected to the launcher.

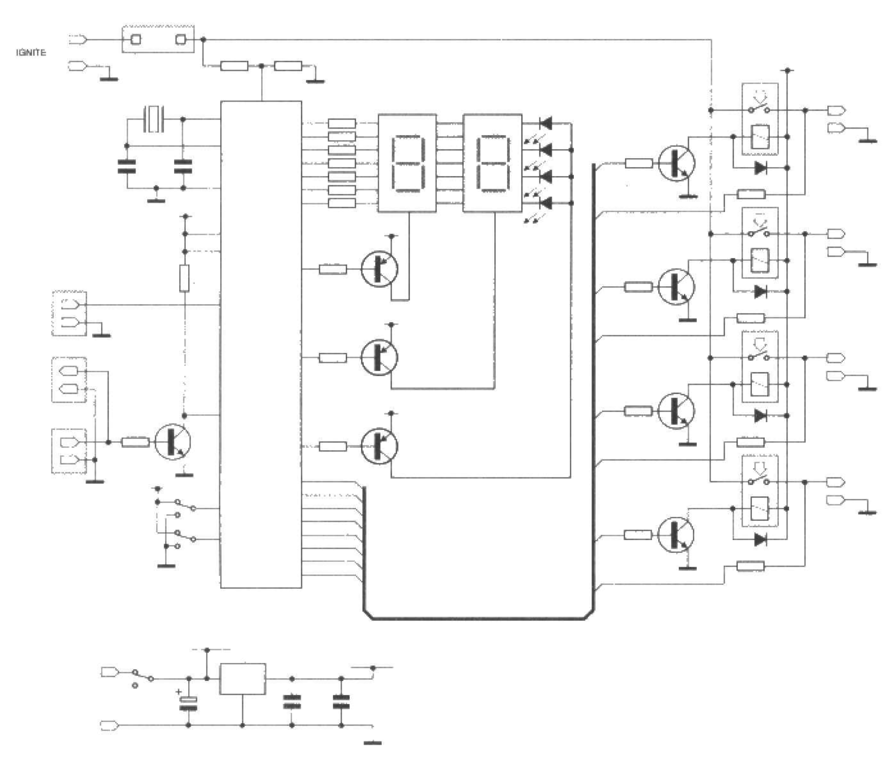


Figure 2: the circuit of the rocket launcher

The mode switches have the following function:

Switch 1	Switch 2	Function
Down	Down	All rockets fired immediately when the firing button is pressed. Seven-segment display is not used.
Down	Up	Fire rockets one at a time in sequence. One rocket on each firing key press. The display shows the rocket fired.
Up	Down	Fire rockets at the end of the 10 second time-out. The display shows the 10 second countdown.
Up	Up	Fire rockets at one second intervals. The display shows the rocket number as each is fired.

The LEDs light when a rocket is connected to the launcher. This may be used to confirm correct connection of each igniter.

The 7-segment displays show 00, and the displays and the LEDs flash when the safety key is not connected. This may be used as a confirmation that the safety key is removed.

The circuit

Figure 2 shows the circuit diagram of the launcher. As the project comprises a fairly complex logic sequence, and drives an LED display, a PIC microcontroller was an obvious choice. A device with a large number of I/O connections is required for this project as the controller must drive 7-segment displays, digit drives, four relays, four sense inputs, and the mode and fire keys. In fact, 24 of the I/O pins are used, thus implying one of the 40-pin PIC devices - in this case the PIC16C74.

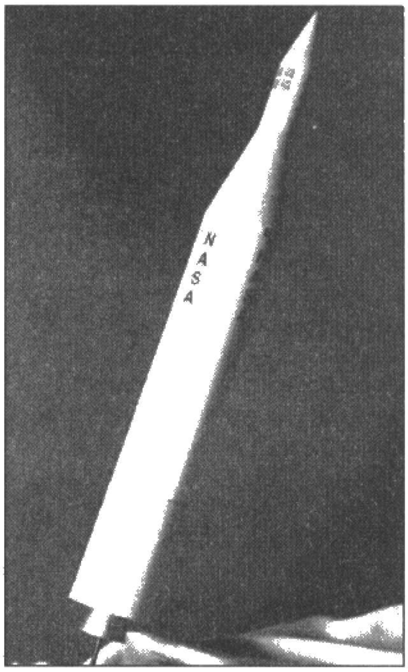
The LEDs used to show which igniters are connected and the 2-digit 7-segment displays are all multiplexed on a common 7-bit drive. The port pins used for driving the displays may seem to be randomly distributed, but in fact were chosen for the easiest PCB layout, as I find it easier to modify software to handle out of order LED segment drives than to lay out PCBs. The display common anodes are driven from PNP driver transistors.

The power supply for the controller is separate from the igniter supply. This is due to the extremely low resistance of the igniter (which drops as the igniter heats). If the controller and igniter share the same supply the voltage drop as the igniter draws current was sufficient in the prototype to cause the relay to drop out, and to crash the PIC controller. The igniter never lit! The supply for the controller module may be 9V (for example,. PP3), or as in the prototype may be four AA batteries (the regulator used is an extremely low dropout device. The igniter supply may be any voltage from 1.5V (used for some thunderflashes), 6V (used for rocket igniters) up to a maximum of 24V, which is the DC limit switch voltage of the relays. The safety key is in series with the igniter battery, and therefore completely isolates the igniter relays, even if a controller fault pulls in the relays there will be no supply to the igniters.

The sense input for the safety key is driven from R12 and R13. The input is normally low, and pulled high when the safety key is inserted. Note that the input/output pins of the PIC (in common with most CMOS devices) have static protection diodes down to the Vdd supply pins. Therefore resistor R12 is required to limit the current drawn from the igniter power supply, especially when the igniter supply is 12V.

There are four igniter relays which are driven by transistors Q5-8. The diodes in parallel with the relays quench the inverse voltage generated by the relay coils as the transistors turn off. The igniters are sensed by resistors R15 to R18, these drive the port B inputs which are configured with the internal pullups enabled. Thus when the igniter is connected the sense input is pulled low. The resistor is required for the same reason as for the safety key input - to protect the PIC inputs when the relays pull in connecting the input to the igniter supply.

Finally, the mode of the launcher is set by switches Mode1



This Juno II was built using the instructions in Peter Alway's The Art of Scale Model Rocketry. Modeller Sven Knudson scribed card stock for the corrugations at the base of the rocket. He was unsatisfied with the way they showed up after painting, so he marked each corrugation with a pencil to emphasise it. The decals are from the Saturn Press decal set. Photos courtesy of Sven Knudson

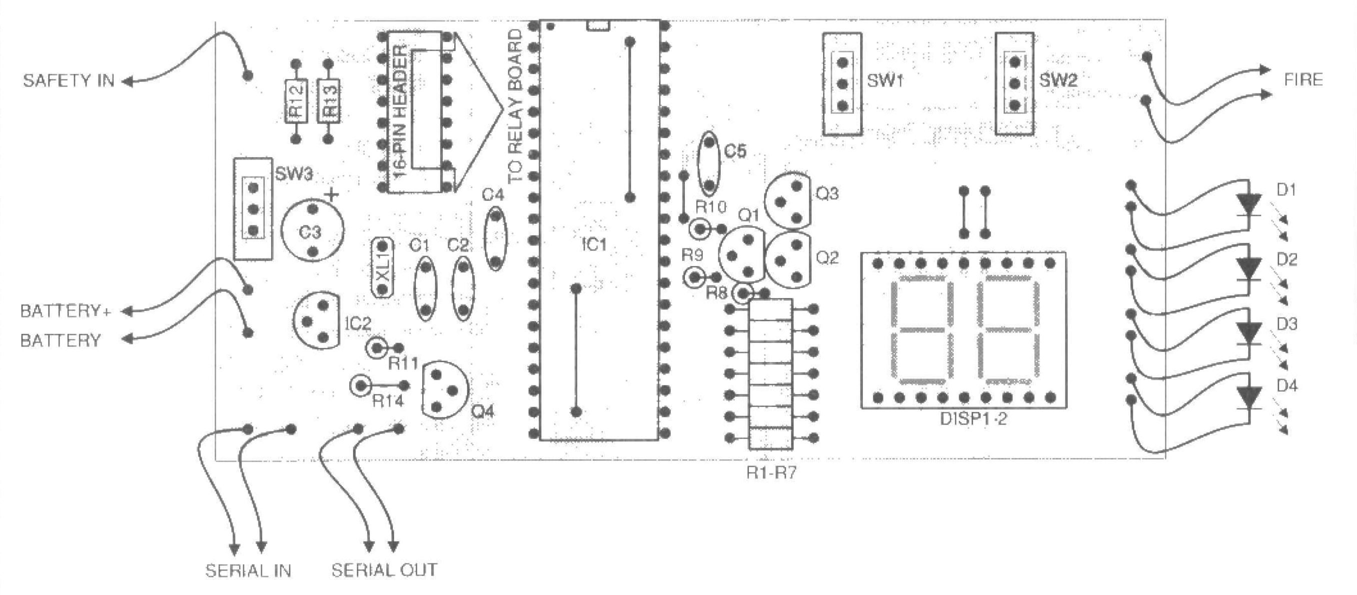


Figure 5: the component layout for the main circuit board

and Mode2, and the serial input from the PC is a simple transistor buffer/inverter. The oscillator shown is a ceramic resonator, but for this application it would be possible to use an RC oscillator, as timing is not critical.

Software

The PIC is hardly stretched in this application, the system operates two interrupt timers. The first is roughly once every 4 milliseconds used for the multiplexed display drive. The second interrupt operates 10 times a second and is used for all system timing and for scanning the press buttons. For the rest of the time the PIC operates in simple loops waiting for buttons to be pressed, or for timers to expire.

For interest the logic flow diagram for the main software loops is shown in figure 3.

Although timing for this application is not critical, the system actually operates on a very accurate clock which causes an interrupt every 100ms. This is not the most difficult part of the software, but it is worth showing how it is achieved with a 4MHz clock, as the author has been consulted on this subject on a number of occasions. The reason why it seems difficult at first is that the internal timers of the PIC may be set to cause an interrupt when they overflow, and this will only happen on a multiple of 256us with a 4MHz clock.

The solution to this problem is to use the Compare facility of the 74. This allows the system to generate an interrupt every time that the 16-bit counter/timer reaches a value which is the same as the compare register. The interrupt routine should then update the compare register to generate another interrupt at the end of the next time period.

The code in figure 4 is a self-standing program which demonstrates this as an example to other programmers. It performs no function, but simply increments a variable called IntCount exactly once every 100ms with a 4MHz clock.

Figure 4: example code for accurate timing on the 74

```
#include "d:\pic\p16c74.inc"
#define TIMER1TIME .12500  ; 12500 counts of timer 1 is
100mS

cblock 0x20                         ; Block of RAM variables
          IntCount                  ; Counts interrupts
          STATUS_TEMP               ; Stores STATUS in interrupt
routine
          W_TEMP                    ; Stores W in interrupt routine
endc

          org 0                     ; Reset vector
          call init
          goto MainLoop

          org 4
inthand   goto introutine

;
; This is the main loop, replace with application code !
;
MainLoop            goto MainLoop

;
; Initialisation routine
;
init      bcf INTCON,GIE                ; Interrupts off
          movlw 0x30I@TMR1ON            ; Timer 1 on, 8us clock
          movwf T1CON
          clrf TMR1L                    ; Clear timer 1
          clrf TMR1H
          movlw TIMER1TIME              ; Write to compare register
          movwf CCPR1L
          movlw TIMER1TIME>>8
          movwf CCPR1H
          movlw 0x0a
          movwf CCP1CON                 ; Set timer 1 to Compare
                                        mode
          bsf STATUS,RP0
          bsf PIE1,CCP1IE               ; Enable compare interrupt
          bcf STATUS,RP0
          clrf IntCount
          bsf INTCON,PEIE               ; Enable peripheral
                                        interrupts
          bsf INTCON,GIE                ; Enable interrupts
```

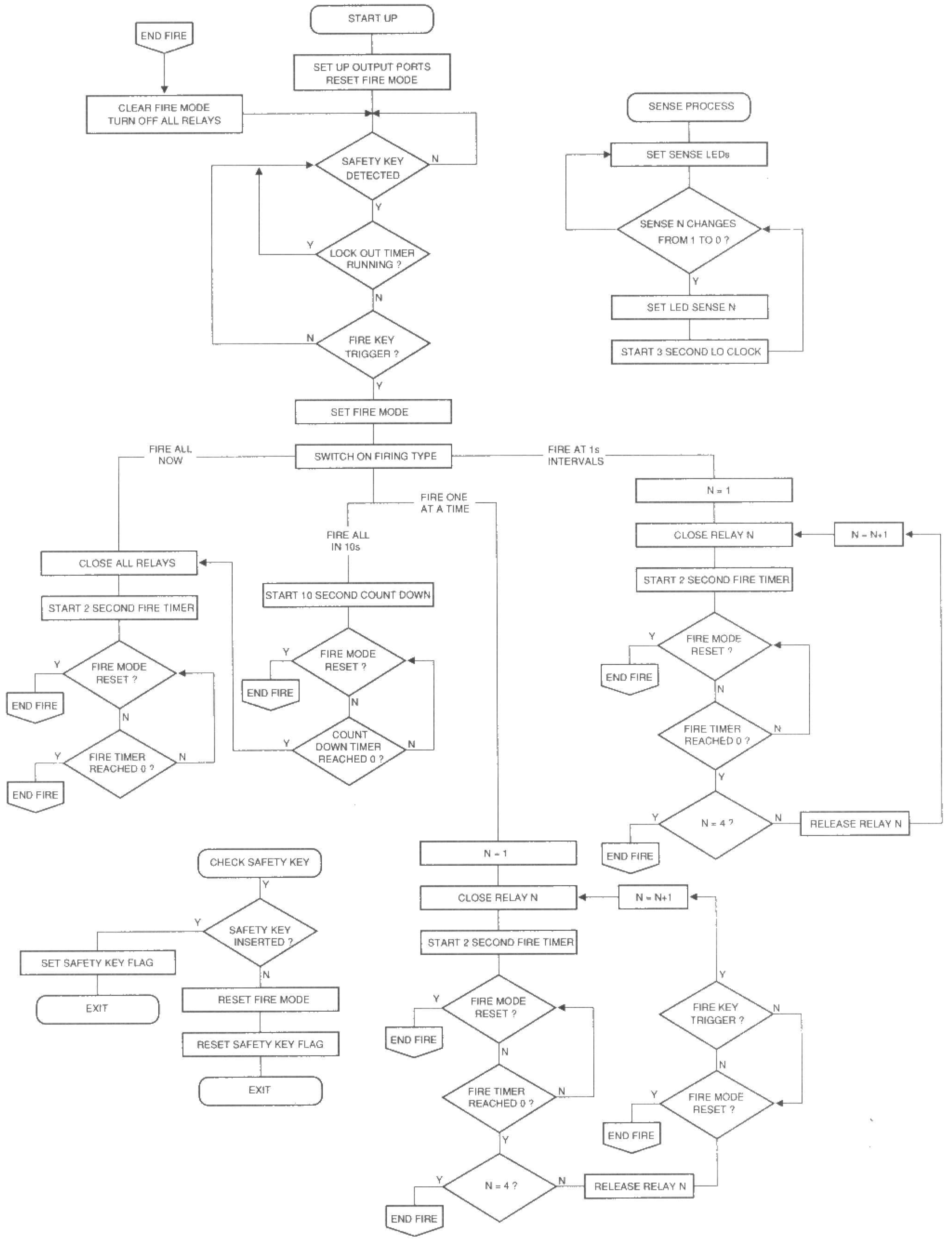


Figure 3: a firing sequence flow diagram

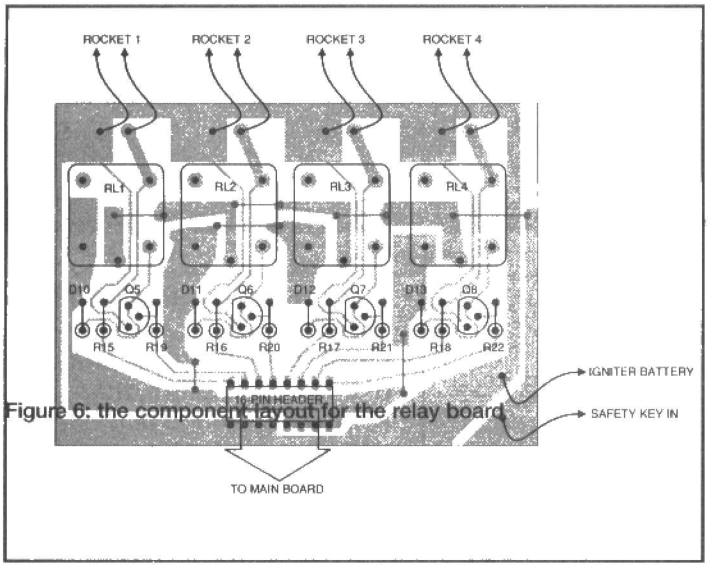


Figure 6: the component layout for the relay board

```
        return
;
; This is the code which deals with interrupts,
;
introutine MOVWF W_TEMP                 ; Microchip's
status save routine
        SWAPF STATUS,W
        BCF STATUS,RP0
        MOVWF STATUS_TEMP

        btfss PIR1,CCP1IF; Test for compare interrupt
        goto NotCompare1        ; Not a compare interrupt
        incf IntCount           ; Add one to the interrupt
                                count
        bcf PIR1,CCP1IF         ; Clear the interrupt flag
        movlw TIMER1TIME        ; Set up the new compare
                                value
        addwf CCPR1L            ;
        skpnc                   ; 16 bit add
        incf CCPR1H             ;
        movlw TIMER1TIME>>8
        addwf CCPR1H
;
; Other interrupts are actioned here !
;
NotCompare1

intret  SWAPF STATUS_TEMP,W
        MOVWF STATUS
        SWAPF W_TEMP,F
        SWAPF W_TEMP,W
        retfie
```

Construction

The circuit board

referring to the Parts List, note that the relays shown are 5V devices, and the coils of the relays are driven directly from the main board power supply. If the main board uses a 9V battery then the relay coils should be uprated to 9V, although in practice the system will probably operate correctly even if they are not uprated.

There are two circuit boards, one of which holds the relays and relay drivers, the other of which holds the main processor, switches, displays and LEDs. Two boards are used for the project, because the processor and display board is mounted directly to the front panel, and there is insufficient clearance for the relays to be mounted on this board.

The main board overlay is shown in figure 5, note that if the

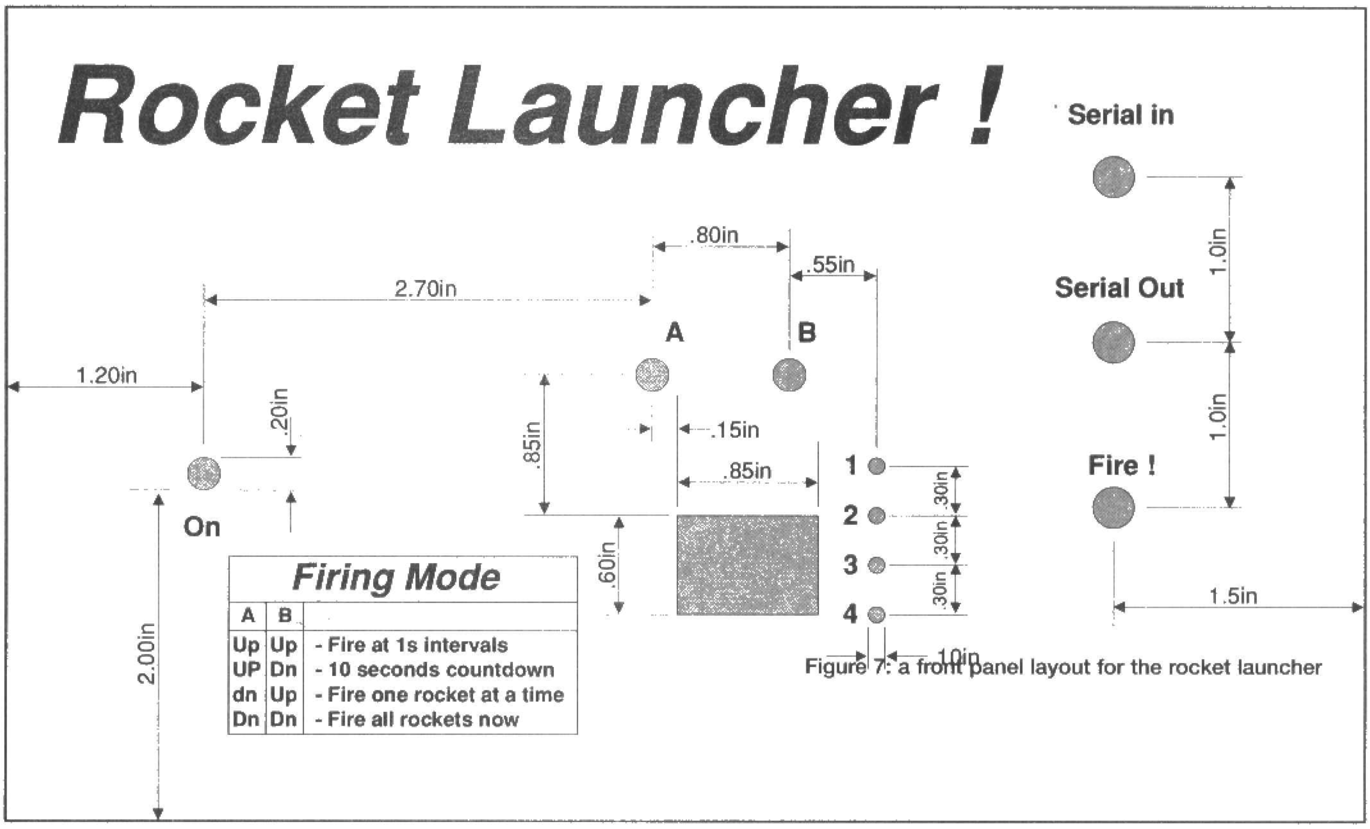
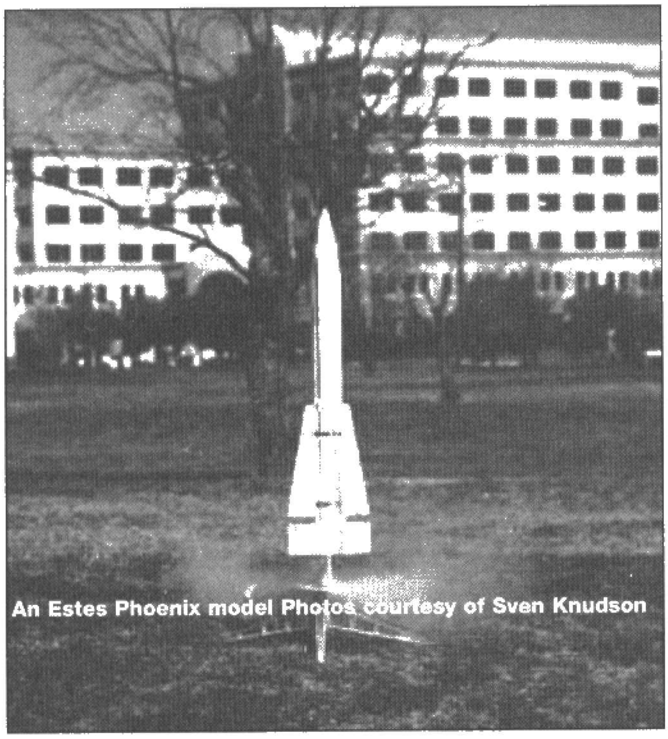


Figure 7: a front panel layout for the rocket launcher



An Estes Phoenix model Photos courtesy of Sven Knudson

serial link is not to be used the main circuit board will not require R14 and Q4. The main circuit board has five links, use snipped component leads for the links, and insert these first. The ic sockets are inserted next. Use an ic socket for IC1, and also for Display 1, the connector for the relay board is also a 16-pin ic socket. Next, solder in the resistors and the capacitors, finally the transistors and IC2. For testing purposes the LEDs (D1 to D4) should be soldered in, but leave them sticking out of the board to the length of the leads as they will be adjusted later. Switches SW1, 2 and 3 are mounted on Veropins soldered into the board to ensure adequate clearance when they are used to mount the board. The centre of the three switch leads needs snipping so that all switch leads are of identical length. The leads must be carefully soldered directly onto the top of the Veropins. All external connections to the board are made by Veropins.

The relay board overlay is shown in figure 6. There are seven links on the board, again these should be soldered first. Follow with the discrete components, the ic socket, Veropins, and finally the relays. If less than four rocket engines are to be driven, the associated circuitry may be left out and included at a later date.

The lead for the connection between the main processor board and the relay board is made from 16-way flat ribbon cable. The connectors are IDC 16-pin headers which fit well into standard ic sockets. IDC connector assemblers are quite expensive, however a simple alternative may be constructed. Solder a scrap 16-pin ic socket into a piece of Veroboard. Press the IDC header pins into the socket and assemble the header around the flat cable. Press the top of the header down by hand, and then complete the assembly by gently squeezing the complete unit with a mole wrench, or in a vice. Note that the headers should be assembled on opposite sides of the cable to ensure that pin 1 is connected to pin 1.

The safety key used in the prototype was a US mains plug and socket with the plug shorted out. Clearly this key would be completely unacceptable in countries which use this kind of plug and socket for mains supply, and in these countries a different plug/socket must be used. The safety key may be any plug and socket which allows a physical method of breaking the circuit, and which can carry the currents drawn, which can reach two or more amps with larger igniter batteries. Do not use a key switch unless the key cannot be removed in the on position. This is very important, as it is vital that the safety key cannot be enabled while the key is removed from the launcher.

Testing

For testing purposes the project should be assembled outside the main case allowing faults to be rectified far more easily. Directly solder the firing push button to the veropins, and use test leads with crocodile clips to connect test resistors to the rocket connections. Connect the safety key. Cable up the batteries for the main processor board and relay board, and connect the boards with the ribbon cable. Insert IC1 and the display, and power up the system.

Check that the system operates as described above. To simulate rocket igniters being connected to the system, the test leads should be connected to 100-ohm resistors. The voltage across the resistor may be measured to verify relay operation. Remember that the fire button is disabled for 3 seconds following power up, and for 3 seconds following connection of a rocket.

Case

The case used for the project is a Maplin type M1006. This case has an offset aluminium front panel on which the processor and display board is mounted. The drilling pattern for the front panel of the case is shown in figure 7. The holes for the firing button and serial input/output sockets are on the right, all the other mounting holes are for the switches. Glue a small piece of red filter over the display hole. This is essential for viewing in daylight. Four holes need drilling in the rear of the case for the grommets for the rocket cables, and for the prototype the safety key was also mounted on the back panel of the case. The relay board and battery holders are fixed to the base of the case using double sided adhesive pads.

Unsolder the LEDs D1 to D4, but leave them loosely fitted into the board holes, connect short cables to all pins on the main board, and plug in the ribbon cable. Fit the main board to the front panel and fix it firmly in case by screwing on the switch nuts. Now carefully move the LEDs so that the top of the LED fits snugly behind the front panel hole. Solder the leads of the LEDs into the board.

The firing button is connected through a phono socket. The lead used was a single cored microphone lead, and the button mounted in a 35mm plastic film canister. Do not use a jack plug for the lead, as the plug may cause a short - and an accidental rocket firing - when it is inserted.

Resolder all the cables and check that the project still operates properly before assembling the case.

Using the launcher safely

As with any rocket launching system (be it electrical or simply a match), the safety of the system depends on the operator displaying common sense and taking all sensible precautions. With this system the operator must take out the safety key whenever connecting rockets to the launcher. This provides a strong guarantee of safety. The display will flash whenever the key is removed, and this may be used as confirmation that the key is removed and that there is no internal short that might fire the rocket. The unit should be powered up whenever connecting rockets to allow the three second safety time-out to operate when new rockets are connected, although the time-out operates automatically on power up.

Please follow the instructions provided with the rocket

£1 BARGAIN PACKS

– List 5

One item only per pack unless otherwise stated.

TEST PRODS FOR MULTIMETERS with 4mm sockets. Good length very flexible lead, ref D86

8 OHM PM SPEAKERS, size 8 x 4", pack of 2. These may be slightly rusty and that is why they are so cheap, but are electrically OK. Ref D102.

PAXOLIN PANELS size 6 x 6", approximately ¹⁄₁₆" thick, pack of two, ref D103.

13A SOCKET, virtually unbreakable, ideal for trailing lead, ref D95.

PIEZO BUZZER with electronic sounder circuit, 3 to 9V DC operated, Ref D76.

DITTO but without internal electronics, pack of 2, Ref D64.

LUMINOUS ROCKER SWITCH, approximately 30mm sq, pack of 2, Ref D64.

ROTARY SWITCH, 9 pole 6 way, small size and ¼" spindle, pack of 2, Ref D54.

FERRITE RODS, 7" with coils for Long and Medium waves, pack of 2, Ref D52.

DITTO but without the coils, pack of 3, Ref D52.

SLIDE SWITCHES, SPDT, pack of 20, Ref D50.

MAINS DP ROTARY SWITCH with ¼" control spindle, pack of 5, Ref D49.

ELECTROLYTIC CAP, 800uf at 6.4V, pack of 10, Ref D48.

ELECTROLYTIC CAP, 1000 + 1000uf 12V, pack of 10, Ref D47.

MINI RELAY with 5V coil, size only 26 x 19 x 11mm, has 2 sets changeover contacts, Ref D42.

MAINS SUPPRESSOR CAPS. luf 250V AC, pack of 10, Ref 1050.

TELESCOPIC AERIAL, chrome plated, extendable and folds over for improved FM reception, Ref 1051.

MES LAMP HOLDERS, slide on to ¼" tag, pack of 10, Ref 1054.

PAX TUBING, ¼" internal diameter, pack of 2, 12" lengths, Ref 1056.

ULTRA THIN DRILLS, .4mm, pack of 10, Ref 1042.

20A TOGGLE SWITCHES, centre off, part spring controlled, will stay on when pushed up but will spring back when pushed down, pack of 2, Ref 1043.

HALL EFFECT DEVICES, mounted on small heat sink, pack of 2, Ref 1022.

12V POLARISED RELAY, 2 changeover contacts, Ref 1032.

PAXOLIN PANEL, 12 x 12" ⅛" thick, Ref 1033.

MINI POTTED TRANSFORMER, only 1.5VA 15-0-15V or 30V, Ref 964.

ELECTROLYTIC CAP, 32uf at 350V and 50uf section at 25V, in aluminium can for upright mounting, pack of 2, Ref 995.

PRE-SET POTS, 1 meg, pack of five, Ref 998.

WHITE PROJECT BOX, with rocker switch in top left-hand side, size 78 x 115 x 35mm, unprinted, Ref 1006.

6V SOLENOID, good strong pull but quite small, pack of 2, Ref 1012.

FIGURE 8 MAINS FLEX, also makes good speaker lead, 15m, Ref 1014.

HIGH CURRENT RELAY, 24V AC or 12V DC, 3 changeover contacts, ref 1016.

LOUD SPEAKER, 8 ohm 5W, 3.7" round, Ref 962.

NEON PILOT LIGHTS, oblong for front panel mounting, with internal resistor for normal mains operation, pack of 4, Ref 970.

3.5MM JACK PLUGS, pack of 10, Ref 975.

WONDER PLUGS, pack of 10, Ref 986.

PSU, mains operated, 2 outputs, 1 9..5V at 550mA and the other 15V at 150mA, Ref 988.

ANOTHER PSU, mains operated, output 15V AC at 320mA, Ref 989.

PHOTO CELLS, silicon chip type, pack of 4, Ref 939.

LOUD SPEAKER, 5" 4 ohm 5W rating, Ref 946.

230V ROD ELEMENTS, 500W terminal ended 10" long, pack of 2, Ref 943.

LOUD SPEAKER, 7 x 5" 4 ohm, 5W, Ref 949.

LOUD SPEAKER, 4" circular 6 ohm 3W, pack of 2, Ref 951.

FERRITE POT CORES, 30 x 15 x 25mm, matching pair, Ref 901.

PAXOLIN PANEL, 8 ½ x 3 ½ with electrolytics 250uf and 100uf, Ref 905.

CAR SOCKET PLUG, with PCB compartment, Ref 917.

4 CORE FLEX, suitable for telephone extensions, 10m, Ref 918.

VERO OFF CUTS, approximately 30 square inches of useful sizes, Ref 927.

PROJECT CASE, 95 x 66 x 23mm with removal lid held by 4 screws, pack of 2, Ref 976.

SOLENOIDS, 12 to 24V, will push or pull, pack of 2, Ref 877.

2M MAINS LEAD, 3 core with instrument plug moulded on, Ref 879.

TELESCOPIC AERIAL, chrome plated, extendable, pack of 2, Ref 884.

MICROPHONE, dynamic with normal body for hand holding, Ref 885.

CROCODILE CLIPS, superior quality flex, can be attached without soldering, 5 each red and black, Ref 886.

BATTERY CONNECTOR FOR PP3, superior quality, pack of 4, Ref 887.

LIGHTWEIGHT STEREO HEADPHONES, Ref 898.

PRESETS, 470ohm and 220K, mounted on single panel, pack of 10, Ref 849.

THERMOSTAT, for ovens with ¼" spindle, to take control knob, Ref 857.

12-0-12V 10 W MAINS TRANSFORMER, Ref 811.

18-0-18V 10W MAINS TRANSFORMER, Ref 813.

AIR SPACED TRIMMER CAPS, 2 to 20pf, pack of 2, Ref 818.

AMPLIFIER, 9 or 12V operated Mullard 1153, Ref 823.

2 CIRCUIT MICRO SWITCHES, Lincoln, pack of 4, Ref 825.

LARGE SIZED MICRO SWITCHES (20 x 6 x 10mm), changeover contacts, pack of 2, Ref 826.

MAINS VOLTAGE PUSH SWITCH with white dolly through panel mounting by hexagonal nut, Ref...

POINTER KNOB, for spindle which is just under ¼", like most thermostats pack of 4, Ref 833.

TOROIDAL MAINS TRANSFORMERS

All with 220/240V primary winding.

0-30V + 0-30V at 120VA would give you 30A at 4A or 60V at 2A, price £8. Order Ref 8PG2.

0-110V + 0-110V at 120VA would give you 110V at just over 1A or 220V at ½A, price £8, Order Ref 8PG3.

0-35V + 0-35 at 150VA would give 35V at 4A or 70V at 2A, price £8, Order Ref 8PG9.

0-35V + 0-35V at 220VA would give 35V at 6 ½A or 70V at 3 ¼A, price £9, Order Ref 9PG4.

0-110V + 0-110V at 220VA would give 110V at 2A or 220V at 1A, price £10, Order Ref 10PG5.

0-45V + 0-45V at 500VA would give 45V at 11A or 90V at 5 ½A, price £20, Order Ref 20PG7.

0-110V + 0-110V at 500VA would give 110V at 5A or 220V at nearly 3A, price £25, Order Ref 25PG8.

NORMAL MAINS TRANSFORMERS

5V 45A, £20, Order Ref 20P16

6V 1A, 2 for £1, Order Ref 9

8V 1A, £1, Order Ref 212

9V ½A, 2 for £1, Order Ref 266

9V 1A, £1, Order Ref 236

9V 3A, £2, Order Ref 2P408.

10V 1A, £1, Order Ref 492

12V ½A, 2 for £1, Order Ref 10

12V 1A, £1, Order Ref 436

12V 2A, £2, Order Ref 2P337.

12V 3A, £3, Order Ref 3P181.

15V 1A, £1, Order Ref 267

17V 1A, £1, Order Ref 492

18V 1 ½A, £1, Order Ref 491

20V 4A £3 Order Ref 3P106

24V ½A £1 Order Ref 337

24V 1A, £2, Order Ref 2P413.

24V 1 ½A, £2.50, Order Ref 2.5P15.

25V 10A, £20, Order Ref 20P33.

28V 2 ½A, £4. Order Ref 4P24.

30V 25VA, £2.50, Order Ref 2.5P25.

40V 2A, £3 Order Ref 3P107.

43V 3 ½A, £5, Order Ref 5P262.

50V 15A £20 Order Ref 20P2.

675V 100mA, £5, Order Ref 5P166.

4kV 2mA, £5, Order Ref 5P139

6-0-6V 5VA, 2 for £1, Order Ref 612.

6-06V 10VA, £1, Order Ref 281

7.5-0-7.5V 8VA, £1, Order Ref D104.

7.5-0-7.5V 50VA, £4, Order Ref 4P98.

8-0-8V 8VA, £1, Order Ref 212.

12-0-12V 3VA, £1, Order Ref 636.

12-0-12V 6VA, £1, Order Ref 811.

12-0-12V 30VA, £2.50, Ref 2.5P15.

15-0-15V 1VA, £1, Order Ref 937.

15-0-15V 15VA, £2.50, Ref 2.5P24.

18-0-18V 10Va, £1, Order Ref 813.

20-0-20V 10VA, £1, Order Ref 812.

20-0-20V 10VA, £2, Order Ref 2P85.

20-0-20V 20VA, £2, Order Ref 2P138.

20-0-20V 40VA, £3, Order Ref 3P205.

20-0-20V 80VA, £4, Order Ref 4P36.

25-0-25V 40VA, £3, Order Ref 3P206.

36-0-36V 20VA, £2, Order Ref 2P156.

SPECIAL TRANSFORMERS

15VA gives 1V 7V 8V 9V or 10V, £1, Order Ref 744.

38-0-38V 150VA with regulated winding, £10, Order Ref 10P36.

230-115V auto auto transformer 10VA, £1, Order Ref 822.

230-115V auto transformer 1kVA, £20, Order Ref 20P29.

230-115V auto transformer 300VA can be made from our Ref 4P97. This is a big mains transformer but it has 1 115V tapping on its primary, £4.

SUPER WOOFER LOUDSPEAKERS

Two available. The first is a 10" 4 ohm with a power rating of 250W music and normal 150W. Has a very heavy magnet and is beautifully made and finished by Challenger. Normal selling price for this is £55 + VAT, you can buy at £29 including VAT and carriage, Order Ref 29P7.

The second one is a 8" 4 ohm, 200W music, 100W normal. Again, by Challenger, price £18, Order Ref 18P9. Incidentally, as these are so heavy, if you collect, then you will make a saving of £2 on the 10" and £1.50 on the 8".

LOUDSPEAKERS

2" round 50ohm coil ½W speaker, pack of 2, £1, Order Ref 908.

2 ¼" 8 ohm, pack of 2, £1, Order Ref 454.

2 ½" 35 ohm, pack of 2, £1, Order Ref 514.

3 ½" 8 ohm, pack of 2, £1, Order Ref 682.

5" 4 ohm, pack of 2, £1, Order Ref 136.

6 ½" 4 ohm with tweeter, £1, Order Ref 895.

6 ½" 6 ohm, £1, Order Ref 896.

6 ½" 8 ohm with tweeter, £1, Order Ref 897.

6 ½" 4 ohm 12W (superior make with Hitachi tools), £1, Order Ref 900.

6 x 4" 4 ohm, £1, Order Ref 242.

5 x 5" 15 ohm, £1, Order Ref 906.

5 x 3" 16 ohm, pack of 2, £1, Order Ref 684.

8" 15 ohm Audax, £1, Order Ref 504.

3" 4 ohm tweeter, £1, Order Ref 433.

6 ½" 4 ohm Sanyo speaker 10W, £1.50 Order Ref 1.5P11.

6 x 4" 15 ohm 10W, £2, Order Ref 2P167.

6 ½" 4 ohm Hitachi speaker with tweeter, £2, Order Ref 2P301.

20W tweeter 4 ohm, £1.50, Order Ref 1.5P9.

Tweeter on flange with crossover. £3, Order Ref 3P86.

Horn speaker, £3, Order Ref 3P82.

5" 20W loudspeaker by Goodmans for Ford, £3, Order Ref 3P145.

8" 8 ohm Amstrad 15W speaker with matching tweeter, £4, Order Ref 4P57.

Midi speaker in cabinet 4 ohm 5W, £5, Order Ref 5P137.

Boxed speakers 4 ohm, £5 each or pair for £8, Order Ref 8/14L.

Double wound voice coil 25W speaker, ITT, £7, Order Ref 7P12.

Bulkhead speaker, metal cased, £10, Order Ref 10P43.

25W 2 way crossover, pack of 2, £1, Order Ref 22.

40W 3 way crossover, £1, Order Ref 23

BIG BUYERS DISCOUNT

Many of the items on this page are are available in quantity and if you order 10 of an item, you can deduct 10%, 50 of an item 15%, 100 of an item 25%, or a mixed order totalling £200 from items on this page, again 25% discount.

TERMS

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J & N FACTORS
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Telephone: 01444 881965

engines, in particular the recommendation that the rockets are used only under responsible adult supervision, and are fired only in suitable locations. Estes recommend that rockets are fired at least 5m away, and in the event of a launch failure the rocket must be left for at least one minute before approaching it to attempt to re-launch it.

If less than four rockets are connected, attach the rockets to the lower numbered cables: therefore with two rockets to launch, connect them to cables 1 and 2.

Figure 8: the code for the 16C74

```
:04000000A720052808
:10000800E9287B20A4102411241A0C28072824117D
:10001800A001A101241E0528A708031D0B28241DE3
:100028000C282411A4142C08AD002E08033C031935
:1000380059282E08023C031964282E08013C03198C
:100048003E28A0010130A90029088E202908A10016
:100058001E30A200A41C3A28A208031D2E287B20CB
:10006800290804 3C03193A28A90A2828A4107B2047
:10007800A7010C28A0010130A900A10029088E20A1
:100088002908A1001E30A200A41C3A28A208031DBA
:1000980048287B202908043C03193A28A41C3A283C
:1000A800241D52282411A90A4228A001A101802058
:1000B8001E30A200A41C3A28A208031D5E283A2874
:1000C8000A30AB000130A000A101A411A41C3A28F9
:1000D800A41D6A28A411A008031DA003A108031DDC
:1000E80077280A30A100A103031D6A2859280510A2
:1000F800851005118511 0800B0012D183014AD18B0
:10010800B0142D193015AD19B0150508FC053004CB
:1001180085000800B000043C031D9428AD1985151E
:100128003008033C031D9A282D1905153008023C98
:1001380031DA0288514AD183008013C031D0800D4
:100148002D18051408008B137B20FF30FF30850025
:10015800860087008800073089008316051085 10FF
:1001680005118511071207138710871107118712C8
:100178000710081288120813831287000816 8816B9
:100188000817033083168100831231309000 8E01E6


:100198008F01D43095003030960 00A3097008B16C6
:1001A8000B1783160C158312A401AA01A701A2013B
:1001B800AC01A501A601AF01A801A001A10111216F
:1001C8000A30AB008B1748210800B100030E8312D8
:1001D800B2000C1D0529AF0AAB0BF528A4150A308F
:1001E800AB0011210C11D43095070318960A303052
:1001F80096072414A708031DA703A208031DA2033A
:100208000C290B1D0C290B11A50A0319A60A4B2151
:1002180 0320E8300B10E310E0900AE01061BAE147A
:10022800861A2E1486191D292C142A1C48212A14D2
:100238001F292C102A1006192629AC14AA1C48219B
:10024800AA142829AC10AA1086182F292C152A1DA3
:1002580048212A1531292C112A1106183829AC15DC
:10026800AA1D4821AA153A29AC11AA11861B4029B2
:100278002A1E24152A1641292A12051A462924124B
:10028800A4104729241608001E30A7000800A80A51
:100298002808033C0319A801081688160817241A09
:1002A8005729AF180800A80803195F2928186329D7
:1002B800A81867290813081220080027692988 1236
:1002C800210800276929081 32C08B000FF3087008F
:1002D80030180712B01807133019 8710B019871192
:0E02E800301A0711B01A8712301B07100800D9
:100E0000B0000A3C031C003407308A003008093E59
:100E100082003F3406345B344F3466346D347D34A5
:080E200007347F346F34003405
:00000001FF
```

Obtaining programmed chips

The code for the 16C74 is shown in figure 8. A disk containing the object and source code for the project may be obtained by sending an SAE and a cheque for £5 to Forest Electronic Developments,10 Holmhurst Avenue, Christchurch, Dorset BH23 5PQ. They will take credit card orders on 01425 275962. Alternatively a pre-programmed 16C74 is available from FED for £15.00.

Estes model rockets can be found at most good model shops. A catalogue is available from Estes in the USA at: Estes Industries, 1295 H Street, Penrose, CO 81240, USA. Tel. from UK (for other origins, add the appropriate international code): 00 1 (800) 820 0202; fax 00 1 (800) 820 0203, or on the World Wide Web at http://www.service.com/estes/ estes.html .

All photographs courtesy of rocket builder Sven Knudson. Sven's web site can be found at www.dtm-corp.com/~sven. His email is sven@dtm-corp.com .

PARTS LIST *for the Rocket Launcher*

Resistors

All 1 percent, 0.25 watt

R1-7	360R
R8-10	10k
R11,14	22k
R12	4k7
R13	100R
R15-18	1k5
R19-22	2k

Capacitors

C1,2	22p disc ceramic
C3	100u 10V electrolytic radial
C4-5	100n disc ceramic

Semiconductors

IC1	PIC16C74 - see text
IC2	5V regulator HT7250, Maplin Code LE79
Disp1-3	Dual 7-digit display, 0.5in, CA, Maplin Code BY66
Q1-3	BC557
Q4,5-8	BC548
D1-4	Green LED
D5-D9	Not fitted
D10-13	1N4148

Other components

PL1,2,3	chassis mounted phono sockets
RL1-4	5V, 70ohm coil, 5A relays, Maplin code SD94
SW1,2,3	Miniature SPDT switch, Maplin code FH98

US-type mains plug, safety key

US-type mains socket, safety key

XL1	4MHz resonator

16pin DIL header; 4 x AA type battery clips, see text; twin core cable, 35 mm; case M1006, Maplin code LH64; fire switch - push to make; ic sockets, DIL 16 pin; ic sockets, DIL 18 pin, 0.6in; ic sockets, DIL 40 pin; 1-metre microphone cable for Fire key; PCB; Veropins; phono plug for Fire key; red filter; 30 cm 16-way ribbon cable.

High-Low Timer Module

GCSE Grounding

Terry Balbirnie continues his series of adaptable circuits for GCSE projects with an adjustable delayed timer module

The purpose of this series is to describe some electronic modules which will be of interest to students and hobbyists, particularly those studying for GCSE Technology and similar examinations. All the devices may be used as they stand, or modified to suit a particular application. All have possibilities for experimental work built in to challenge the more ambitious student.

No frills

The circuits are given without frills - they are not built into a box, and there is no on-off switch, for example. These details are left to the constructor. The way in which each device works is described with the aid of the circuit diagram.

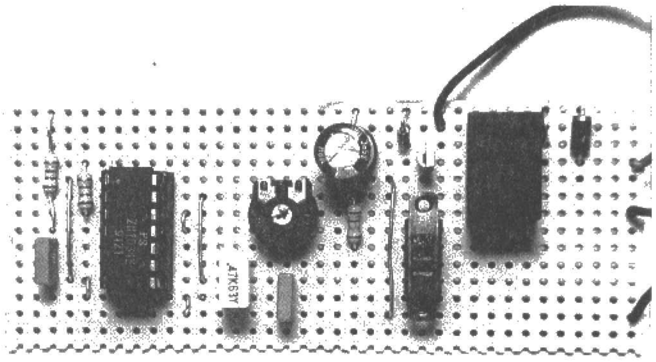
Construction is based on a stripboard (Veroboard) layout. Veroboard is preferred by many students and it is readily available. Also, the inherent "in-line" arrangement of components inherent in stripboard more nearly resembles the arrangement of a circuit diagram than a true PCB does, and is therefore more easy to match to the circuit under study. The relay output means that the circuits are able to control other battery-operated devices such as lamps or motors using a separate supply. They are also able to switch other electronic circuits on or off without any care needed over interfacing.

Note that these circuits must not be used to control mains equipment as this would be very dangerous.

Just in time

This month we shall look at a time delay module which may be used to switch some external device on or off during operation. The "high/low" aspect is provided by a switch on the circuit panel. In one position, the timings may be adjusted from about 30 seconds to 11 minutes. In the alternative position, they may range from about 4 minutes to 2 hours. This makes the circuit suitable for a wide variety of purposes. For example, it could be used for process timing (possibly for photographic work or cookery). It could also be used to operate a radio for a preset time at night so that it will switch off after the user has gone to sleep. The timings are easily changed if required and details for doing this are given later. The total current requirement is about 80mA while timing. This is not important for short timings. However, over long periods the battery would soon be drained. It would then be better to use a commercial plug-in power supply unit. More about this will be said later.

The circuit is shown in figure 1. Power is obtained from a PP9 battery or six AA size cells in a suitable holder (or from a plug-in supply). Diode D2 allows current to flow from supply positive to charge up capacitor C4 which then provides a supply for the circuit. The capacitor provides a reserve of charge and helps to provide stable operation. This is especially useful when the battery is becoming old or when a poorly-smoothed plug-in supply is used. D2 also provides protection if the supply were to be connected with incorrect polarity since then it would be reverse biased and would not allow current to flow.



The principle component is the integrated circuit timer, IC1. This functions with very few external components to provide reasonably accurate time delays. The chip incorporates a digital counter and logic circuitry which enables it to give very long timings with relatively low value components. It operates as follows. Current from the battery positive line flows through resistor R2 to pins 4 and 5. An on-chip 5V regulator then provides a stabilised supply for the ic. The excess voltage - that is, the difference between the nominal 9V input and 5V - appears across R2. Decoupling capacitor C3 is essential for stable operation of the ic. On powering-up, timing begins and pin 3 goes high.

Pin 14 provides a precision 2.5V supply for the timing components (RV1, R1, C1 and C2). Assume that switch SW1 is open (off) for the moment so C1 is disconnected and has no effect. Current flows from pin 14 through preset RV1 and resistor R1 and charges capacitor C2. When the voltage across C2 reaches a certain value, this is detected by pin 13 and the on-chip counter registers "one". The capacitor is then discharged by internal circuitry. The charging process then starts again with the counter keeping a record of the number of charge/discharge cycles. When this reaches 4095, pin 3 goes low and timing is terminated. The ic is then ready to begin a further cycle when the supply is switched off then on

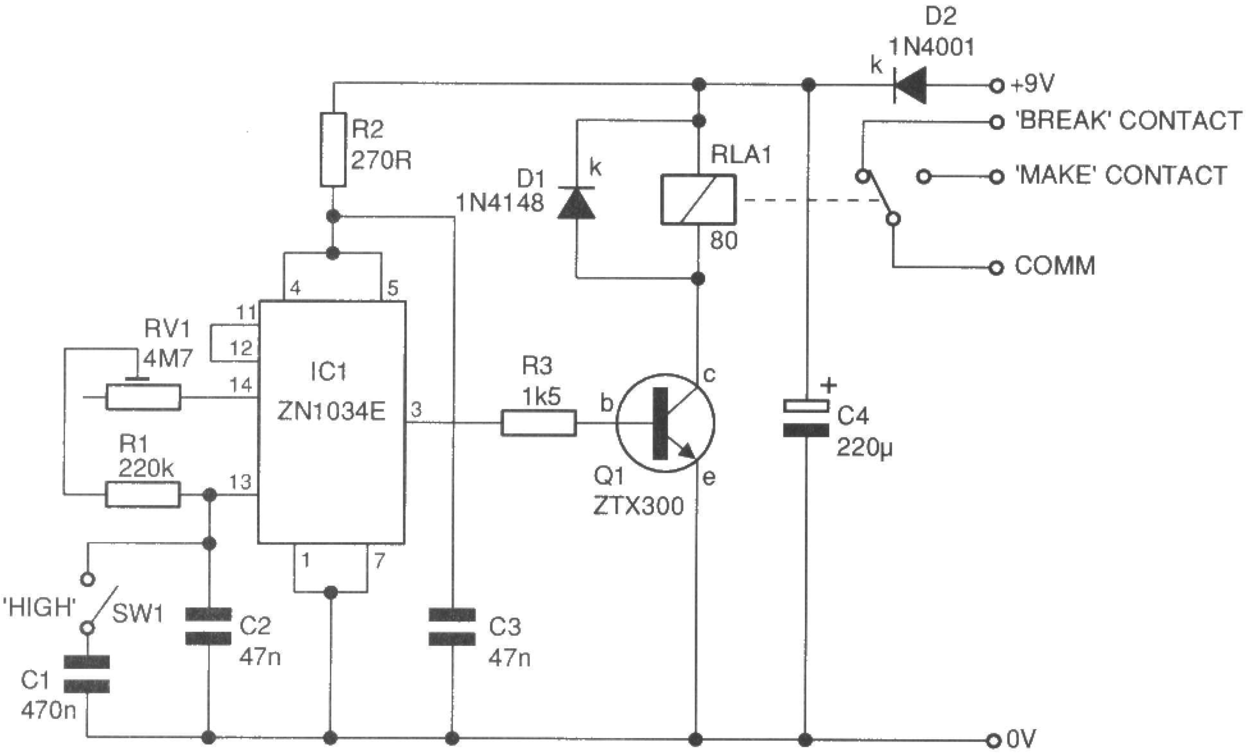


Figure 1: the circuit of the High-Low timer module

again. When SW1 is closed (on), capacitor C1 is connected in parallel with C2 and the overall value is increased. This extends the timings.

While pin 3 is high, current flows through resistor R3 to the base of transistor Q1. This allows collector current to flow through the relay coil. The relay has SPDT contacts and access is provided to both the normally-open ("make") and the normally-closed ("break") ones so that external devices may be switched either on or off during the timing cycle. D1 bypasses the reverse high-voltage pulse which appears across the relay coil when it switches off. Without this, the high voltage could damage semiconductor devices in the circuit.

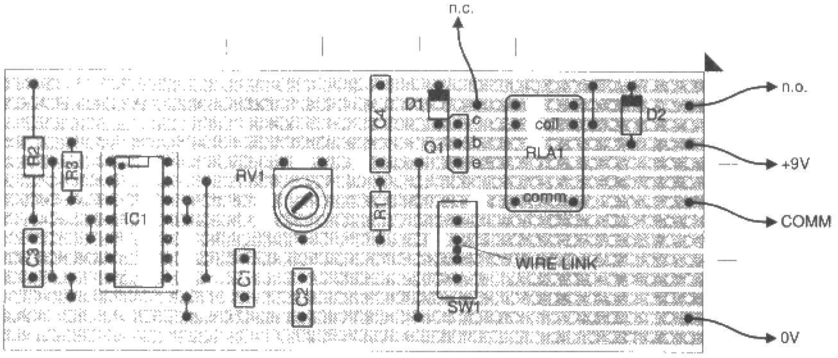


Figure 2: the stripboard layout of the High-Low timer module

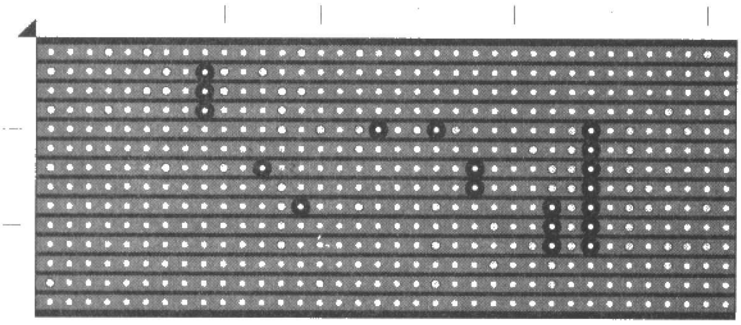


Figure 3: the back of the stripboard layout

Construction

The topside stripboard layout (component side view) is shown in figure 2. Note that a large number of track breaks and inter-strip links are needed. Make the track breaks first, using a proper spot face cutter, then attend to the links. Most causes of malfunction are due to strips not being broken completely, a break or link wire being left out, a break in the wrong place or a blob of solder or sliver of copper bridging adjacent tracks. Some of these mistakes are invisible to the naked eye, so check with a magnifying glass!

Next, solder the switch in position. With the specified unit, the centre tag will not fit the 0.1in. matrix. It will be necessary to drill a small hole between the tracks as indicated. The centre tag is connected to the copper strips on each side of it by soldering a short link wire between them. Do not rely on a blob of solder to do this. Follow by soldering the ic socket in position, the relay, then all remaining components. Take care to mount the transistor, diodes and capacitor C4 the correct way round. Solder battery connectors to the +9V and 0V tracks as indicated. If a plug-in supply is to be used, use the appropriate connector. Solder wires to the required relay contact tracks - the common and either the N/O (normally-open or "make") or N/C (normally-closed or "break"). Probably the "make" contacts are more useful and these are accessible from the edge of the board. Note, however, that the photograph shows wires soldered to the "break" contacts.

Adjust RV1 fully clockwise and switch SW1 off (lever adjusted upwards). This will give minimum timing which is best for testing purposes. Insert the ic taking care over the orientation. This is a CMOS device and could be damaged by static charge - earth yourself by touching a water tap or other earthed point before handling the pins.

Testing

Connect the battery and listen for a click from the relay. It should then switch off again some 30 seconds later. Disconnect the battery. Advance RV1 to give longer timings and switch on again. Check the higher timing range by switching SW1 on (lever downwards).

If you are using a plug-in power supply, make sure that its voltage output does not exceed 12V. If it is of the stabilised type there will be no problem. The inexpensive non-stabilised type will need to be checked since the output voltage is usually stated for full-load conditions and with this circuit it will be loaded only lightly. You may find that a 6V nominal supply provides 9V under a light load. If it has a polarity reversing plug, it is quite in order to try it one way round and if the circuit does not work, reverse it.

Ideas for experiments

Remember, this circuit must not be used to operate mains devices.

To extend to time periods, capacitors C1 or C2 could be increased in value. Alternately, increase the value of RV1 or R1. If the timings need to be adjusted from outside the case, remove RV1 and connect wires from a standard panel-mounting potentiometer to the same positions. If a motor or a lamp requiring more than about 1A is to be operated, it will be necessary to up-rate the relay with one having appropriately rated contacts.

PARTS LIST for the High-Low Timer

Resistors

R1	220k
R2	270R
R3	1k5
RV1	4M7 min horizontal preset

Capacitors

C1	470n min metallised polyester
C2	47n min metallised polyester
C3	100n min metallised polyester
C4	220u 16V PCB electrolytic

Semiconductors

IC1	ZN1034E
Q1	ZTX300
D1	1N4148
D2	1N4001

Miscellaneous

RLA1 Miniature relay with 6V coil and 2A "make" contacts; 0.1 in matrix stripboard; PP9 battery and connectors; 14-pin dil socket.

The relay used in the prototype was type FM91Y from Maplin.
The switch was type FF77J from Maplin.

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Computer-controlled Christmas Light Show

Pei An uses his Centronics port to drive a "melody" of programmable light patterns

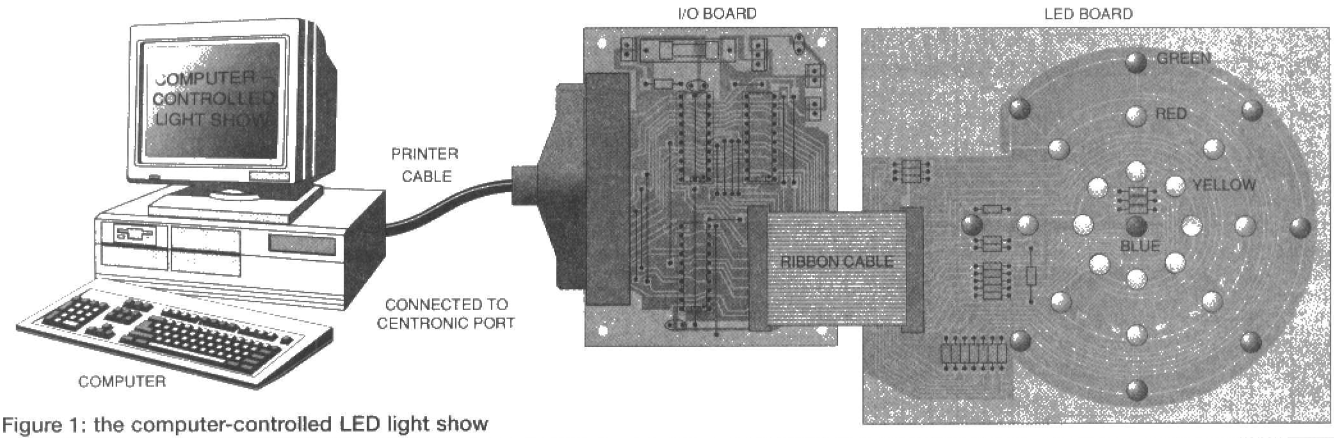


Figure 1: the computer-controlled LED light show

his article describes a computer-controlled LED light show system. There are 24 LEDs (8 red, 8 green and 8 yellow) arranged in three concentric circles on the display board (see Figure 1). with one blue LED in the centre. The board is connected to an I/O control board via a 26-way ribbon cable. The control board is then connected to the computer's Centronics port using a printer cable. The lighting sequence for each LED is programmable. Users can write software to output different lighting sequences and thus achieve various visual effects.

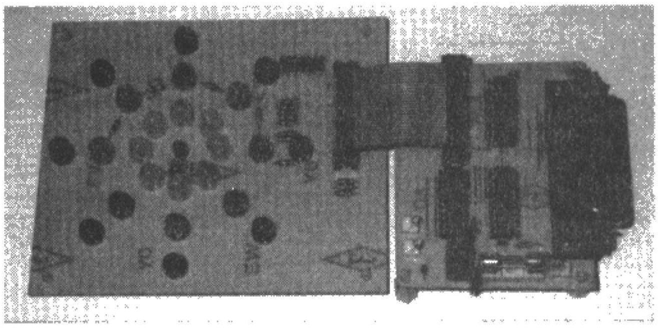
The project can be a fancy hi-tech decoration at home. If you have several such devices running, you probably can just about bring the Blackpool Illuminations into your home.

The hardware principle is very easy to understand and the project is easy to construct. Programming the light sequence is great fun. You can use your imagination to create any visual effects you like. If you are a bit lazy, you could let your computer to 'compose' its own melody of lights...

The works

The system consists of two boards: the I/O board and the LED (display) board. The I/O boards is connected to the printer port of a PC, and provides 24 output lines. The LED board contains 25 LEDs of 10mm diameter.

The details of the Centronics port are described in the article 'Centronics Mini-Data Lab' in ETI Volume 26 Issue 2, earlier this year.



The circuit diagram of the I/O board is shown in Figure 2. It contains three 74LS374 octal latches (IC1, IC2 and IC3). The pin-out of the 74LS374 is given in Figure 3. When latching a data to the output, firstly, the data is applied to the inputs (D). The a low-to-high-then-low pulse is applied to the CLK pin (pin 11). At the low-to-high transition, the input data is latched to the output. In the circuit, data inputs to the three latches are provided by the Data port of the Centronic port. DB0, DB1 and DB2 of the Control port are connected to CLK inputs of IC1, IC2 and IC3, respectively. The output ports A, B and C are available from J1 and the pin-out functions of the connector are shown in figure 5.

The I/O board requires an 8 to15V DC 1A power supply. The voltage is converted to +5V using an on-board voltage regulator. A fuse is used to limit the total current consumption within 500 mA.

The circuit diagram of the LED display board is shown in Figure 4. Each LED is driven by one output of the 74LS374 latches. A resistor is connected in series with the LED to limit the LED current below 15 mA. The LEDs used are 10mm-diameter LEDs, and there are 24 of them arranged in three circles of 8 LEDs each, with a blue LED in the centre. In my display, the inner circle has yellow LEDs; the middle circle has red LEDs and the outer circle has green LEDs. They are controlled by Port B, Port C and Port A, respectively.

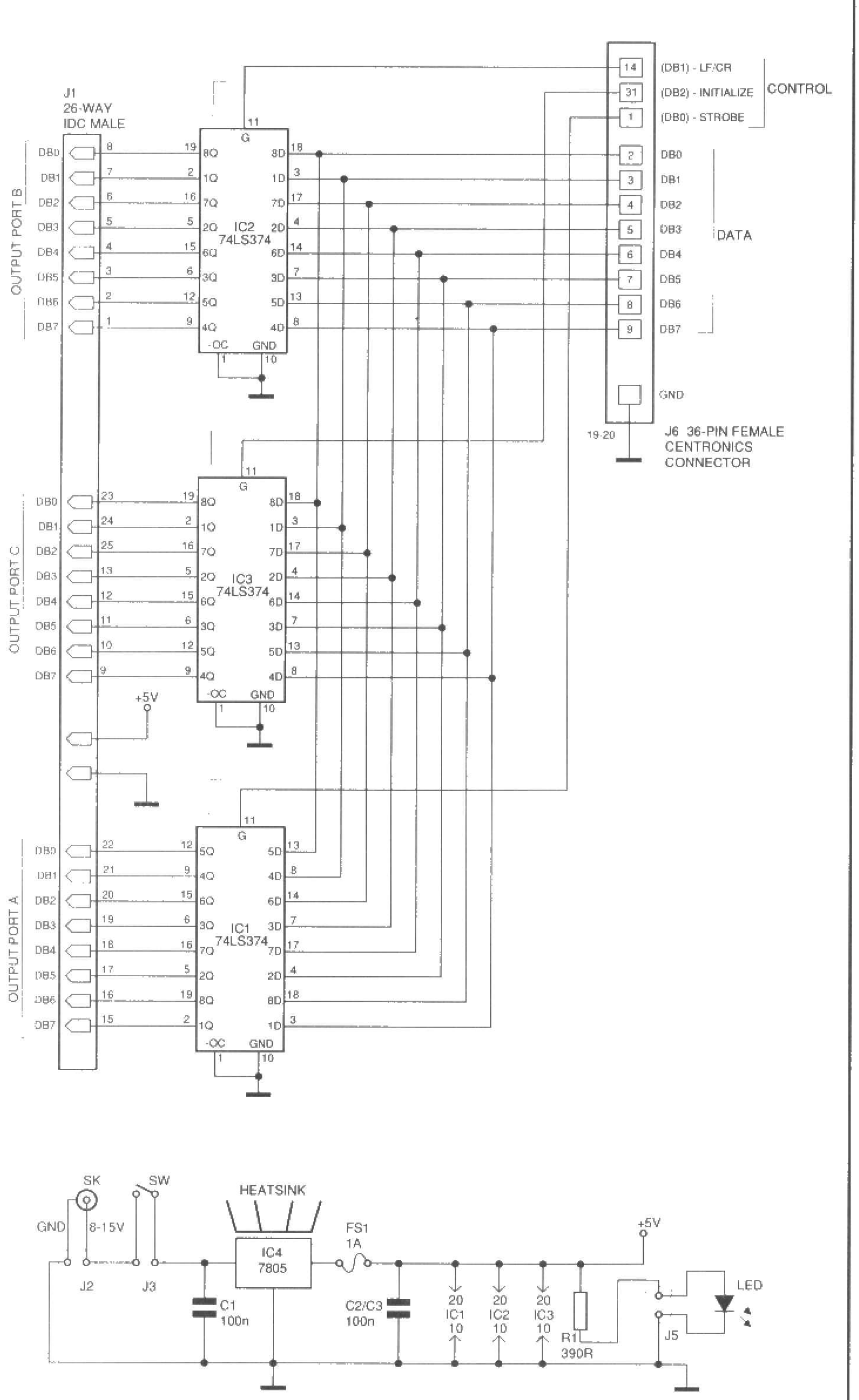


Figure 2: the circuit diagram of the Centronics I/O card

Construction

The two boards are constructed on single-sided PCBs. The component layout of the I/O board and the LED board are shown in figure 5.

Construction of the boards is straightforward. Care should be taken to ensure that the polarity of the LEDs is right. When soldering LEDs on the PCB, keep the soldering time as short as you can to make a good connection, as LEDs can be heat-sensitive.

Programming

The Turbo Pascal 6 program for the project is listed below. Readers can convert the program into Basic or other programming languages.

The present program contains some useful functions and procedures. Procedure Input_printer_address reports the number of Centronics ports installed on your pc and allows you to select a printer port. Procedure write_port(port_number,port_data:byte) writes port_data into one of the three 74LS374 latches specified by port_number. The port_data could be a value from 0 to 255 and the port_address could be 0, 1 or 2. This is the only I/O control procedure in this program. Procedure Timer(second:real) is a timer procedure. If the time elapsed is in excess of the second, it will set the time-out flag (a Boolean number) true.

When you run the program, it first reports the number of Centronics ports installed on you pc and asks you to select a printer port to which the light show board is to be connected to. After this, the program will play a number of light-effect melodies which I have programmed.

In this demonstration program, I have written some light effect procedures. They are designed to work as follows:

Procedure All_on_off (second) puts all the LEDs on or off at the same time. The time period of this effect is determined by the variable: second. The details of the procedure are given in the program list.

Procedure Binary (second) simply sends binary data from 0 to 255 to the three ports. The lighting sequence of the LEDs is like a binary counter. This is a good demo of binary data.

Procedure Chase (No, effect1, effect2,second) gives an LED chase effect. To find out the functions of parameters, type the program and try it.

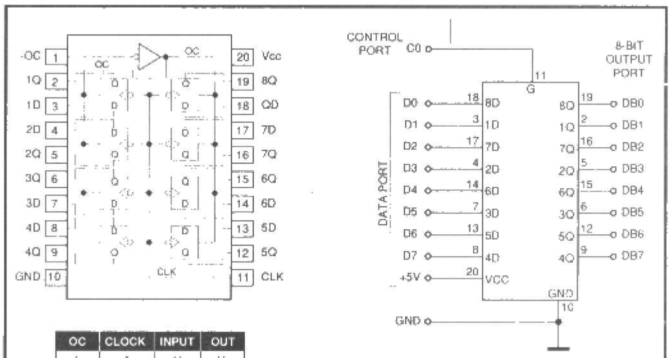
Procedure Red_Green (second) illuminates one red LED and one green LED. The two LEDs rotate in a circle.

Procedure Explode (second) makes the yellow LEDs (the inner circle) light up first, then the green LEDs (the middle circle), and finally the red LEDs (the outer circle) lights up last. It will repeat this action again and again. The effect is exploding circles in different colours.

Procedure All_off will switch off all the LEDs.

This also 'switches off' the descriptions of my demo program.

```
Program Light_show;
{Software driver for PCcontrolled Light Show Pei An 1997}

uses
  dos, crt, graph;
var
  bitnumber,outputbyte:byte;
  P_address, Delaynumber_delay:integer;
  bit:array[1..8] of byte;
  timeoutflag:boolean;
  h1,m1,s1,s1001,h2,m2,s2,s1002:word;
  time1,time2: real;

Procedure find_delay_number_2;
{Check pc speed and find the delaynumber for 1 ms}
var
  time1,time2,dt:real;
  t,h1,m1,s1,s1001,h2,m2,s2,s1002:word;
begin
    clrscr;
    gotoxy(25,24); write('Checking computer speed');
    gettime(h1,m1,s1,s1001);
    time1:=3600*h1+60*m1+s1+s1001/100;
    for t:=1 to 1000 do delay(1);
    gettime(h2,m2,s2,s1002);
    time2:=3600*h2+60*m2+s2+s1002/100;
    dt:=time2-time1;
    delaynumber_delay:=round(1000/dt*0.001);
    clrscr;
    gotoxy(30,24); write('Finished...');
    clrscr;
end;

Procedure Input_printer_address;
{Universal auto detection of printer base address}
{ $000:$0408 holds the printer base address for LPT1
  $000:$040A holds the printer base address for LPT2
  $000:$040C holds the printer base address for LPT3
  $000:$040e holds the printer base address for LPT4
  $000:$0411 number of parallel interfaces in binary format}

var
  lpt:array[1..4] of integer;
  number_of_lpt,LPT_number,code:integer;
  kbchar:char;
begin
    clrscr;
    LPT_number:=1; {defaut printer}
    number_of_lpt:=mem[$0000:$0411]; {read number of
    parallel ports}
    number_of_lpt:=(number_of_lpt and (128+64)) shr 6;
    lpt[1]:=memw[$0000:$0408];  {Memory read procedure}
    lpt[2]:=memw[$0000:$040A];
    lpt[3]:=memw[$0000:$040C];
    lpt[4]:=memw[$0000:$040E];
    textbackground(blue); clrscr;
    textcolor(yellow); textbackground(red); window(10,22,70,24);
clrscr;

    writeln('Number of LPT installed    :  ',number_of_lpt:2);
    writeln('Addresses for LPT1 to LPT 4:  ',lpt[1]:3,'   ', lpt[2]:3,'
    ', lpt[3]:3,'   ', lpt[4]:3);
    write('Select LPT to be used (1,2,3,4)    :  ');
    delay(delaynumber_delay*1000);
```

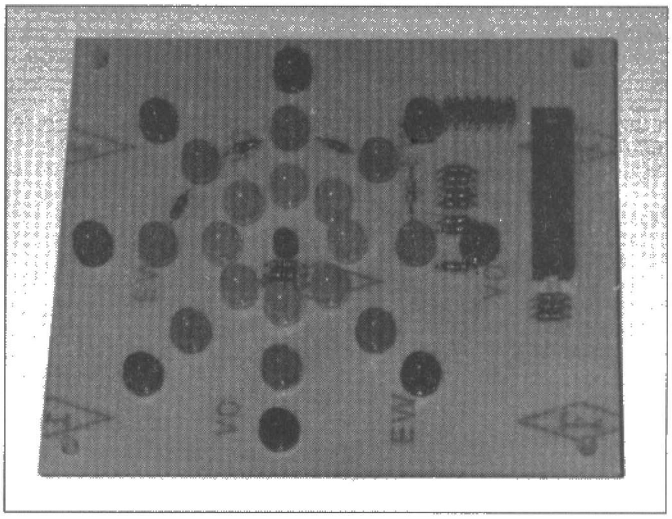


OC	CLOCK	INPUT	OUT
L	↑	H	H
L	↑	L	L
L	L	X	Q0
H	X	X	Z

X: NOT CARE
Z: HIGH IMPEDANCE
Q0: INITIAL STATUS

Figure 3: the pin-out of the 74LS374 and the circuit for expanding an 8-bit port of the Centronics port

```
    if number_of_lpt>1 then begin {select LPT1 through LPT4 if
    more than 1 LPT installed}
      repeat
          kbchar:=readkey;              {read input key}
          val(kbchar, LPT_number, code);  {change character
                                               to value}
    until (LPT_number>=1) and (LPT_number<=4) and
(lpt[LPT_number]<>0);
                                   end;
    clrscr;
    P_address:=lpt[LPT_number];
    writeln('Your selected printer interface: LPT',LPT_number:1);
    write('LPT  Address                  :  ',P_address:3);
    delay(delaynumber_delay*1000);
    textbackground(black); window(1,1,80,25); clrscr;
                         end;

Procedure timedelay;
{A short time delay}
var
  dummy:real;
  i:integer;
begin
          for i:=1 to 50 do dummy:=0;
end;

Procedure initialization;
begin
          port[P_address+2]:=0+2+0; {DSL=1, data load #1=0,
data load #2=0}
```



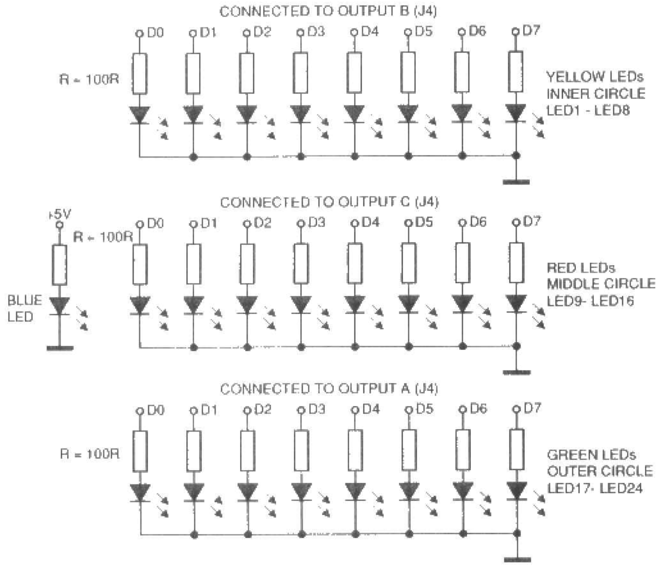


Figure 4: the circuit diagram of the LED board

```
end;

Procedure write_port(port_number,port_data:byte);
{write port_data into one of the 74LS373 D-type latches}
begin
   port[P_address]:=port_data;   {output a byte to the data
port}
   timedelay;
   if port_number=0 then begin
          port[P_address+2]:=0+2+4;  {load data #1=1}
          timedelay;
          port[P_address+2]:=0+2+0;   {load data #1=0,
loading data}
          timedelay;
                   end;
   if port_number=1 then begin
          port[P_address+2]:=0+0+0; {load data #2=1}
          timedelay;
          port[P_address+2]:=0+2+0; {load data #2=0, loading
data}
          timedelay;
                   end;
   if port_number=2 then begin
          port[P_address+2]:=0+0+0; {load data #2=1}
          timedelay;
          port[P_address+2]:=1+0+0; {load data #2=0, loading
data}
          timedelay;
                   end;
end;


Procedure find_bit_weight;
{find the bit weight}
begin
          bit[1]:=1;
          bit[2]:=2;
          bit[3]:=4;
          bit[4]:=8;
          bit[5]:=16;
          bit[6]:=32;
          bit[7]:=64;
          bit[8]:=128;
```

```
end;

Procedure Timer(second:real);

begin
  time1:=3600*h1 + 60*m1 + s1 + s1001/100;
  gettime(h2,m2,s2,s1002);
  time2:=3600*h2 + 60*m2 + s2 + s1002/100;
  if (time2-time1>second) then timeoutflag:=true else
timeoutflag:=false;
end;

Procedure All_on_off(second:real);
begin
gettime(h1,m1,s1,s1001);
repeat
          write_port(0, 255);
          write_port(1, 255);
          write_port(2, 255);
          delay(delaynumber_delay*300);
          write_port(0,0);
          write_port(1,0);
          write_port(2,0);
          delay(delaynumber_delay*300);
          timer(second);
until timeoutflag;
end;

Procedure binary(second:real);
var
```

PARTS LIST for the Computer Controlled Light Show

I/O board

R1	390R 0.25W resistor
C1-C3	100 nF ceramic capacitor
IC1-IC3	74LS374 octal latches (Maplin or Electromail)
IC4	+5V 1A voltage regulator (Maplin or Electromail)
J1	26-way IDC dil connector
J2, J3, J5	2-way PCB connectors
J6	36-way Centronix-type female connector
FS1	Fuse holder
Fuse	500 mA fuse

Heat sink for IC4
PCB (see Technical support for availability and prices.)
26-way ribbon cables with heaters
Pillars to support the PCB

LED board

R2-26	100R 0.25W carbon film resistors
LED1-8	10 mm yellow LEDs (Maplin or Electromail)
LED9-16	10 mm red LEDs
LED17-24	10 mm green LEDs
LED25	10 mm blue LED
J4	26-way IDC dil male connector

PCB (see Technical support for availability and prices.)
Pillars to support the PCB
PCB mounting header for the ribbon cable

```
            i:integer;
    begin
    gettime(h1,m1,s1,s1001);
    repeat
        for i:=1 to 255 do begin
            write_port(0, i);
            write_port(1, i);
            write_port(2, i);
                delay(delaynumber_delay*10);
                    end;
        timer(second);
    until timeoutflag;
    end;

    Procedure chase(no,effect1,effect2:integer;second:real);
    var
            i,data1,data2,j:integer;
    begin
            gettime(h1,m1,s1,s1001);
    repeat
            for i:=1 to 7 do begin
            data1:=bit[i];
            data2:=bit[abs(effect2*8-i)];
            for j:=1 to no-1 do begin
              data1:=data1+bit[i+j];
              data2:=data1+bit[abs(effect2*8-i-j)]
                    end;
            write_port(0, abs(effect1*255-data1));
            write_port(1, abs(effect1*255-data2));
            write_port(2, abs(effect1*255-data2));
              delay(delaynumber_delay*100);
                    end;
        timer(second);
    until timeoutflag;
    end;

    Procedure red_green(second:byte);
    var
        i:integer;
    begin
        gettime(h1,m1,s1,s1001);
        repeat
          for i:=1 to 4 do begin
            write_port(0,bit[2*i-1]);
            write_port(2,bit[2*i-1]);
            delay(delaynumber_delay*100);
            write_port(1,bit[2*i]);
            write_port(2,bit[2*i]);
            delay(delaynumber_delay*100);
            timer(second);
                    end;
    until timeoutflag;
    end;

    Procedure explode(second:real);
    var
        i,data:integer;
    begin
    gettime(h1,m1,s1,s1001);
    repeat
            write_port(0, 255);
            delay(delaynumber_delay*200);
            write_port(1, 255);
            write_port(0,0);
```

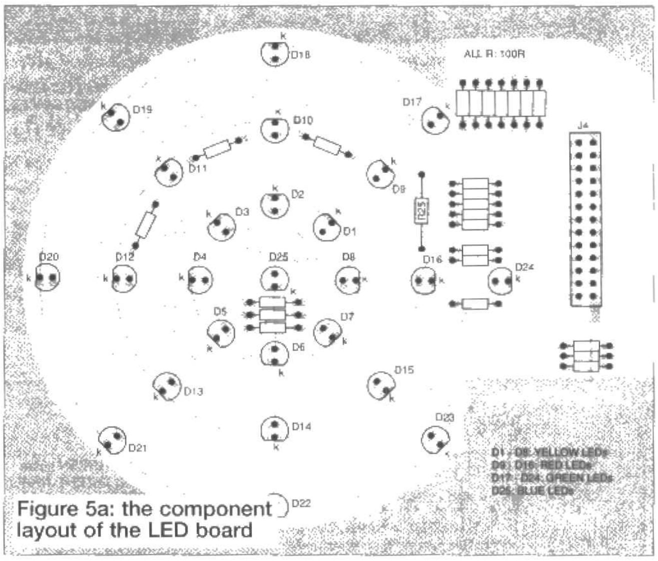


Figure 5a: the component layout of the LED board

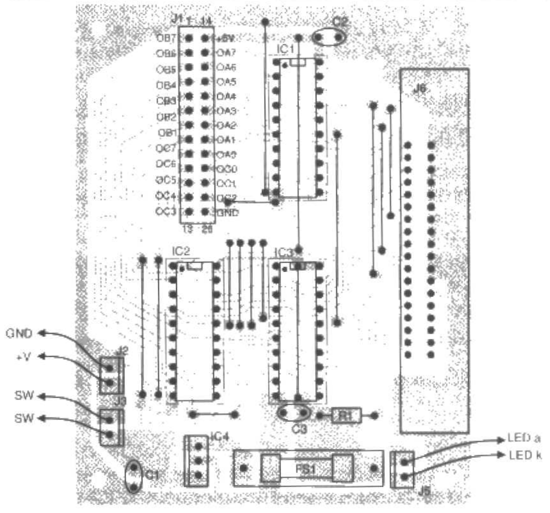
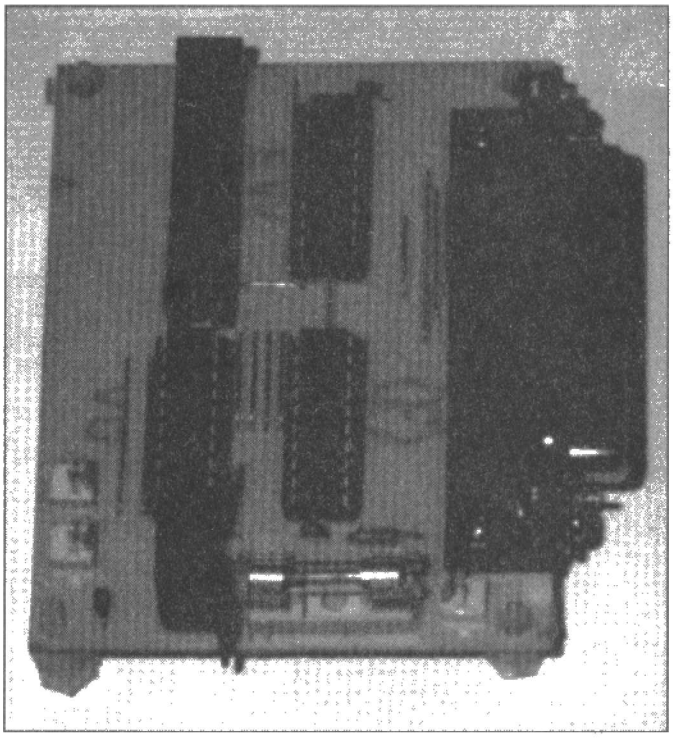


Figure 5b: the component layout of the I/O card

```
            delay(delaynumber_delay*200);
            write_port(2,255);
            write_port(1,0);
            delay(delaynumber_delay*200);
            write_port(2,0);
            timer(second);
    until timeoutflag;
    end;

    Procedure all_off;
    begin
            write_port(0,0);
            write_port(1,0);
    end;

    {************Main program**********}
    begin
        find_bit_weight;
        find_delay_number_2;
        initialisation;
    input_printer_address;
    repeat
            red_green(4);
            chase(1,0,0,2);
        all_on_off(2);
        chase(1,1,1,2);
        explode(2);
        chase(3,0,0,2);
        explode(2);
        chase(3,0,1,2);
        explode(2);
        chase(1,0,0,2);
        explode(2);
        all_on_off(2);
        binary(2);
until keypressed

end.
```



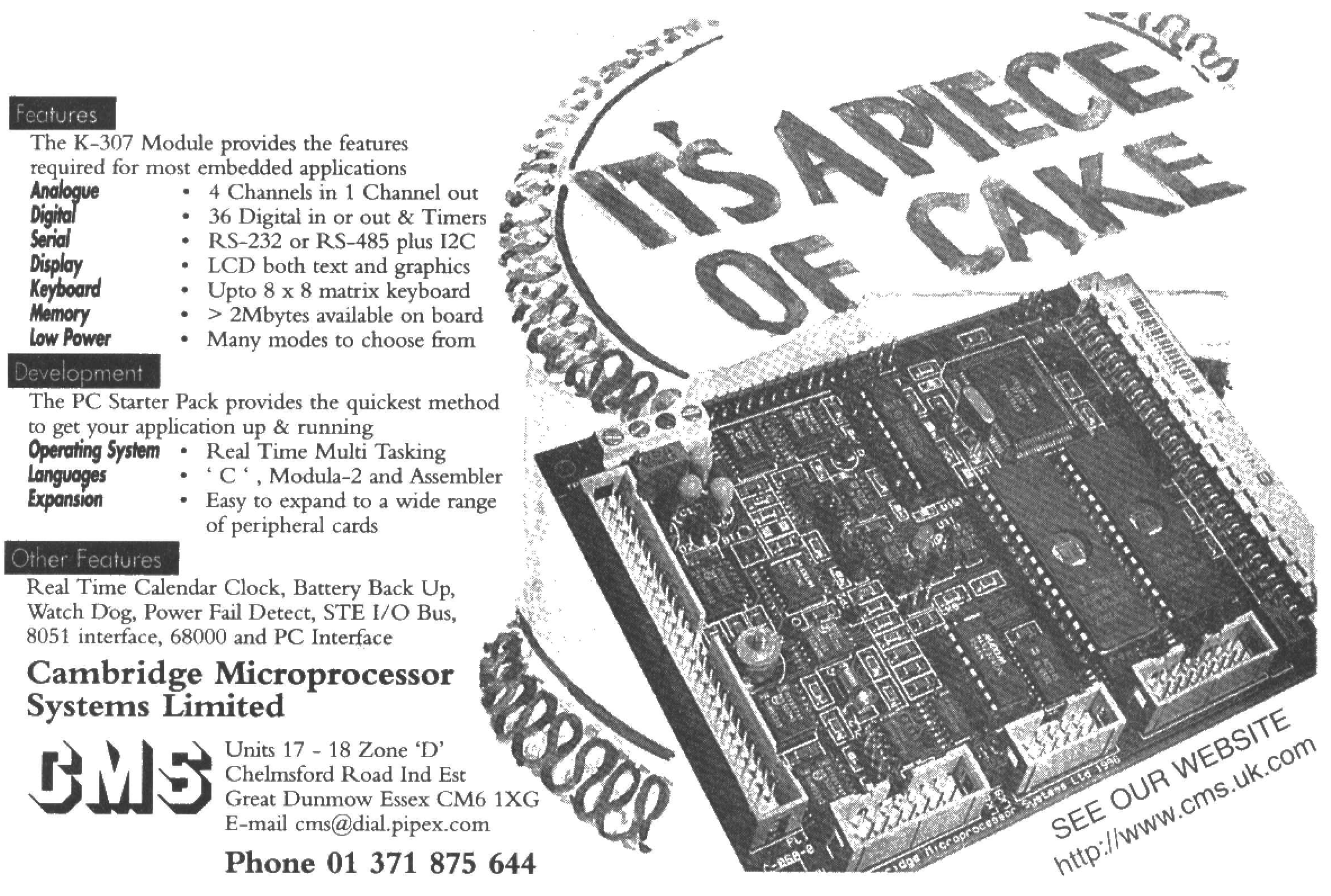
Some ideas

Constructors may find that the LEDs are too small and the light emitted is not bright enough for their preferences. You could improve this by using bigger lights. If the current required by each light is too high, a power driver should be provided. You could also add more lights on your display to give more complicated visual effects. This however requires extra circuitry to expand the outputs of the I/O board.

Now, it's time for you to think about your light effects and write your own procedures!

Technical support

Constructors should be able to obtain most of the components from Maplin, PO Box 3, Rayleigh, Essex SS6 8LR, UK (catalogues from main newsagents) or Electromail, PO Box 33, Corby, Northants NN17 9EL, UK (Tel. 01536 204555). The TP6 software driver (source code and EXE files) is available for £5.00 pounds from the address below. The price of the two PCB together is £15.00. I also have a limited number of kits which put everything together in a package. Please direct your enquiry to Dr. Pei An, 11 Sandpiper Driver, Stockport, SK3 8UL, UK. My telephone and answer phone number is 44+(0)161-477-9583 and my e-mail is PAN@FS1.ENG.MAN.AC.UK.



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THE MIGHTY Midget

This little device for repair and development of audio equipment is Bob Noyes' way of getting an audible indication for audio signal tracing as well as a meter reading.

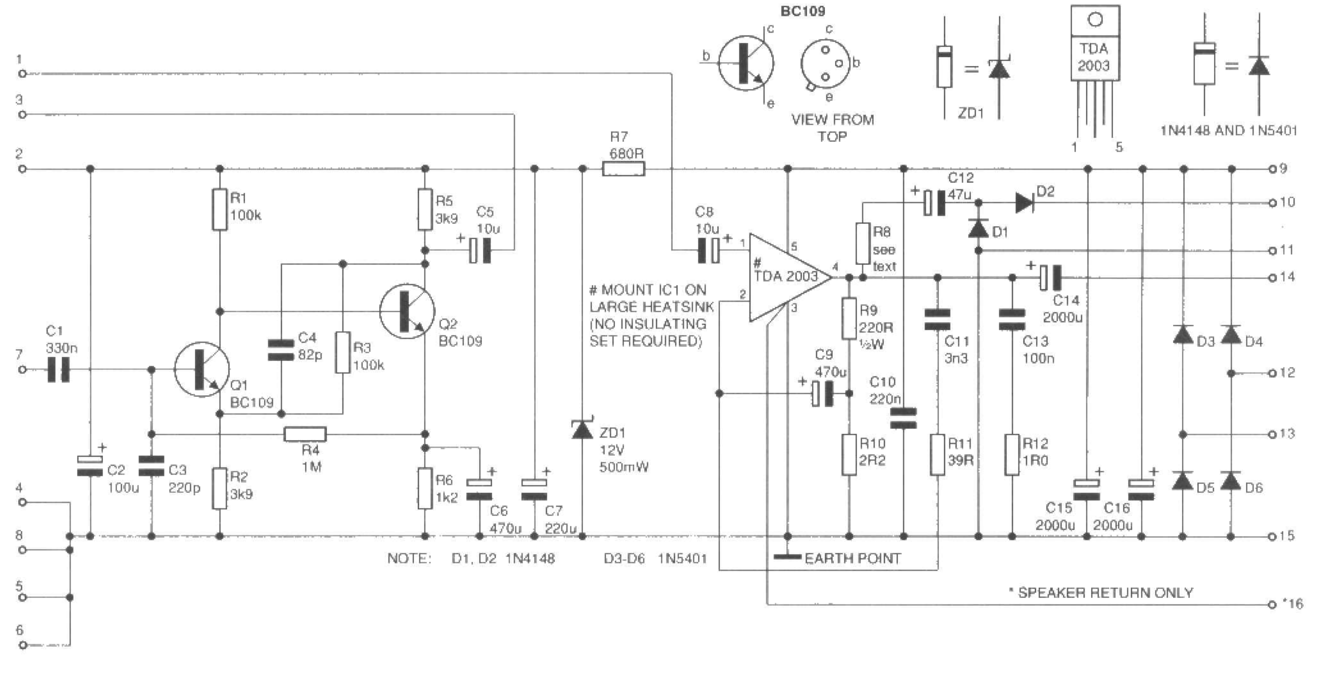


Figure 1: the circuit diagram of the Mighty Midget

For many years I have had an audio signal tracer (or amplifier and speaker) consisting of a good old LM 386 audio amplifier IC and a single transistor pre amp. The LM 386, although a great little amp not requiring many external components, has one drawback: its output is limited to half a watt or so. This limitation is not a problem when using it to trace signals in radios, tape recorders and, dare I say it, record players where the level of signal is fairly constant; but with equipment such as synthesisers and guitar effects units a much greater dynamic range is produced, so in order to reproduce loud and quiet sounds without distortion a more powerful amplifier is needed. A Marshall 4x12 200 watt with KT88s all aglow is ideal, but for bench use something a little smaller and a lot cheaper is required.

Enter the Mighty Midget. The output is capable of some six watts and, although not suitable for stage work, its output is really surprising. Remember, human hearing is not linear, but more logrithmic, so to double the effective volume the power must be increased ten-fold. This is a major problem for groups and discos wanting more and more volume, but it is an advantage coming down the scale, where only a few watts can sound very loud, as my neighbours will testify; combined with a good low impedance speaker or speakers, this will more than do the trick.

PIN NO.	FUNCTION	NOTES
1	POWER AMP INPUT	FROM VOLUME CONTROL
2	+12 VOLTS OUT	5mA MAX
3	PRE-AMP OUTPUT	TO VOLUME CONTROL
4	0V	VOLUME 0V
5	0V	
6	0V	
7	PRE-AMP INPUT	TIP CONTACT JACK SOCKET
8	PRE-AMP INPUT RETURN	SLEEVE CONTACT 0V JACK
9	+18V OUT OR IN	DC ONLY
10	METER +VE OUT	
11	METER -VE OUT	
12	12 VOLTS AC IN	#
13	12 VOLTS AC IN	#
14	POWER AMP OUT	SPEAKER (LIVE)
15	POWER 0V	#
16	POWER AMP OUT RETURN	SPEAKER (RETURN)

Figure 2: the input/output pin connections to the PCB. # - see transformer options

The output stage of the Mighty Midget is a TDA 2003, not to be confused with the more popular TDA 2030 hi-fi amp. The 2003 is about the same size as a TO 220 transistor but has five legs; these are not on 0.1-in spacing, so to aid layout the legs are rearranged and spread out a little so as to conform with it. The metal tab or heatsink is at pin 3 potential, or 0V in

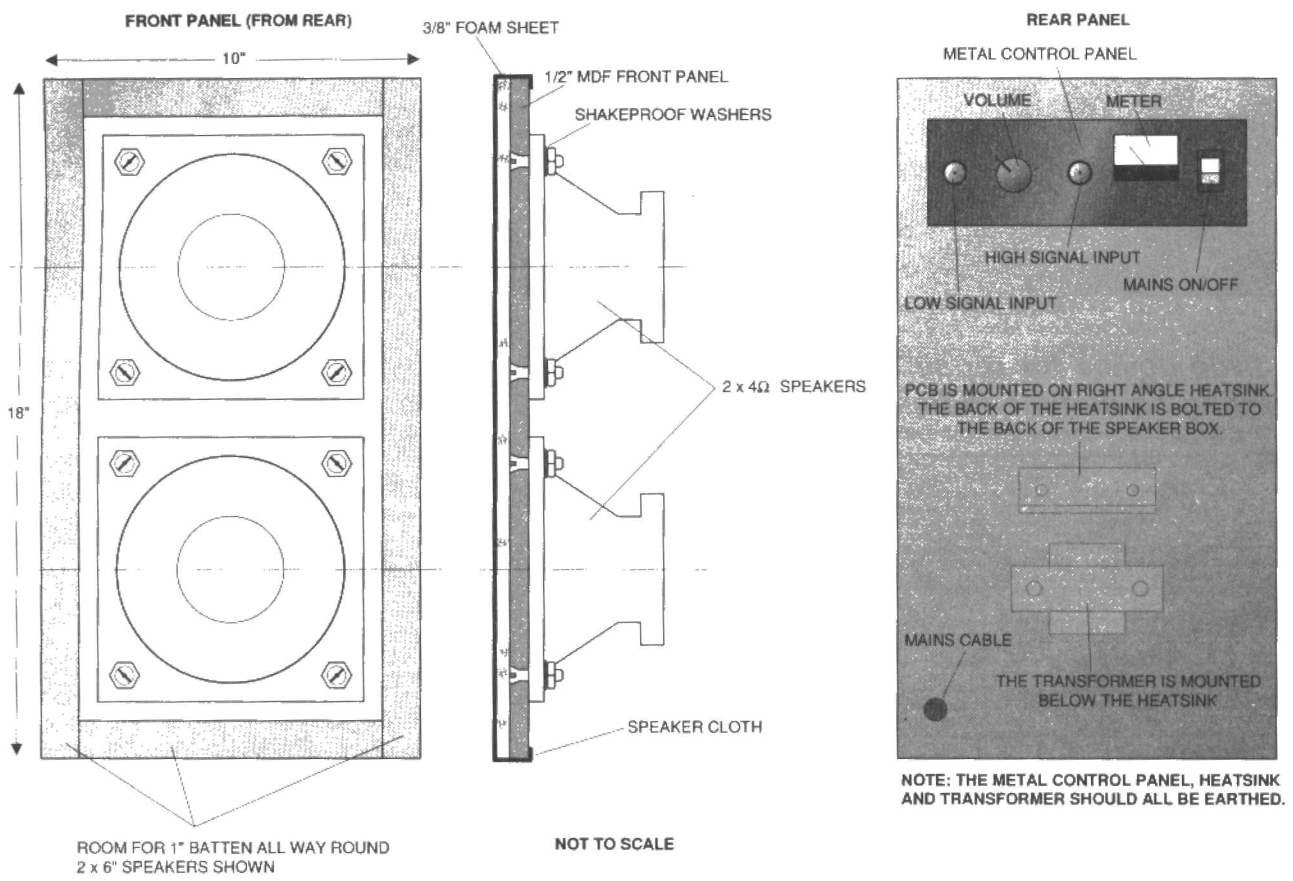

FRONT PANEL (FROM REAR)
10"
18"
3/8" FOAM SHEET
1/2" MDF FRONT PANEL
SHAKEPROOF WASHERS
2 x 4Ω SPEAKERS
SPEAKER CLOTH
ROOM FOR 1" BATTEN ALL WAY ROUND
2 x 6" SPEAKERS SHOWN
NOT TO SCALE
REAR PANEL
METAL CONTROL PANEL
VOLUME
METER
HIGH SIGNAL INPUT
MAINS ON/OFF
LOW SIGNAL INPUT
PCB IS MOUNTED ON RIGHT ANGLE HEATSINK. THE BACK OF THE HEATSINK IS BOLTED TO THE BACK OF THE SPEAKER BOX.
MAINS CABLE
THE TRANSFORMER IS MOUNTED BELOW THE HEATSINK
NOTE: THE METAL CONTROL PANEL, HEATSINK AND TRANSFORMER SHOULD ALL BE EARTHED.

Figure 3a and b: a suggested front panel and rear panel layout

our case. A large heatsink is required to bolt to it, which in this instance is a 85mm long piece of aluminium angle 25mm x 25mm by 3mm thick; this in turn is used to mount the Mighty Midget in the box. The heatsink should be earthed on the bolt holding the TDA 2003 to it. Only one earth connection is made to the 0V in order to prevent earth leaps (that loud humming noise).

NiCad batteries

The gain of the TDA 2003 has been set at around 100 by the ratio of R9 and R10. This ic is a handy little device originally designed for car radios, etc., where it can develop around four watts into 4 ohm speakers without the need for bridging or the use of output transformers.

The only drawback is that the ic is a little inefficient and not suitable for dry battery operation; large capacity nicads can be used, connected into pin 9 via a forward-biased IN 5401 to give the Midget a battery option for field use. Ten to sixteen 1.2 volt batteries will be required, or alternatively a 12 volt alarm battery would do.

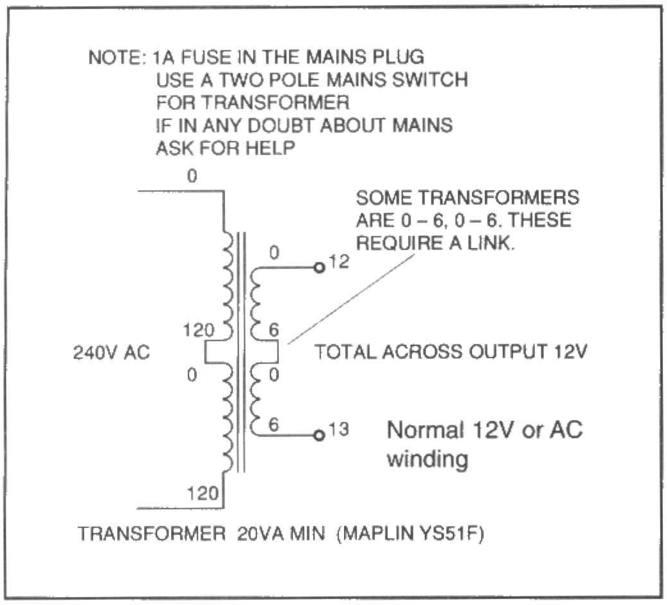
On anything over a few watts consumption an external non-regulated supply is not recommended as the voltage fluctuates depending upon the current being drawn. External regulated supplies are OK, but can get hot in operation, which is never ideal and needs extra ventilation. The advantage of external regulated supplies is that they plug directly into the wall socket, eliminating the risk of any problems associated with exposed mains. However, I chose a built-in (internal) mains supply as the best option, but anyone not familiar with working with mains should seek help from someone qualified. This internal supply is not regulated, but the use of 4,400uF of reservoir capacitor keeps the supply voltage close to 17 volts or so. Although only 12 volts AC is used in the power supply, after full wave rectification and good smoothing (the reservoir capacitors) the resulting DC voltage is close to the peak, hence 17 volts,

The output capacitor used for the TDA 2003 is 2200uF. This is to give a good low frequency response, as the ic rolls off at about 40Hz; to avoid more attenuation at low frequencies a large capacitor is required.

The pre amp is a typical two transistor directly coupled amplifier. Transistors were chosen over an ic because they are far more tolerant of accidental overload. C3 and C4 have been added to reduce the noise generated in the pre amp. This high end loss is not a problem as the TDA 2003 has a roll off at about 15kHz; after all this is a piece of test equipment not a hi-fi system.

If required a passive tone control can be fitted between the output of the pre amp and the volume control [figure ?]. As this is a passive tone control, that is, it does not amplify the bass or treble, only reduces the level of the unwanted frequencies, there will be an overall loss. The preamp has a gain of around 30 and the power amp around 100, so the total gain is around 30 x 100 (or 3000) which means for a frill output of about 15 volts peak to peak an input of around 5mV peak to peak is required. If more gain is required, R2 can be reduced down to 1k or so, but increasing the gain also increases the background noise as well as hum pick up.

A basic audio meter has been included in the Mighty Midget. As can be seen, this is a passive monitor with no active elements. It will indicate anything coming out of the amp, even high frequencies above the normal hearing range. Audio amplifiers under development often oscillate at frequencies above the audio range. This can cause damage to



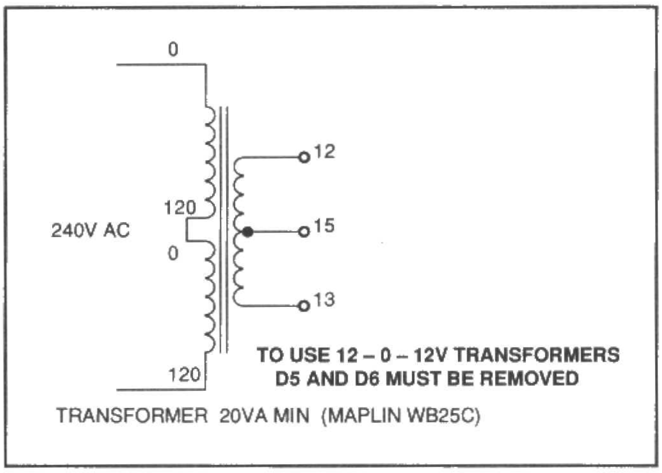
the amplifier, or to the loudspeaker, and if it does neither of these things it can cause distortion the source of which is not easy to determine. The audio meter included in the Midget is capable of registering frequencies much higher than audio so that it can give you evidence of high frequency oscillation if it is occurring. This is invaluable for fault finding.

Meters and speakers

This meter does not conform to peak or VU calibration, but indicates output although it will jig about in time to the output signal. R8 should be selected to give full scale deflection of the meter at the point of clipping of the amplifiers output. Its value will depend upon the type of meter and the current required to produce full scale in it. A cheap meter will do, as there is no advantage in having one that is accurately calibrated when the reading is not. Some meters require backlighting to illuminate them; for this the 12 volt AC should be used on a 14 volt bulb. Having a higher voltage bulb than the supply will extend its life.

Because of the limited frequency response of the 2003 it is not worth using a large, expensive bass speaker. I would suggest one with an 8-in maximum diameter, and again the use of a crossover and tweeter is of limited use due to the high frequency roll off.

To maximise the power out, the speaker (or speakers') impedance should be as near to 2 ohms as possible. To achieve this, two small 4-ohm speakers can be connected in parallel. 4-in or 6-in speakers will do fine, and can normally be obtained as car radio speakers, a lot cheaper than hi-fi speakers.

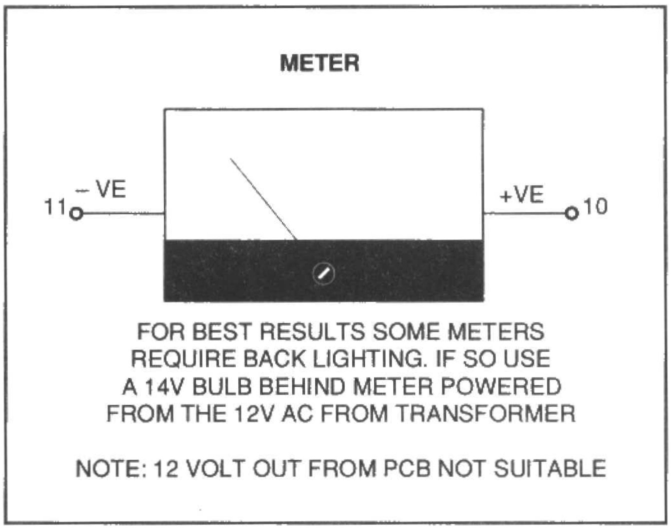

0
12
240V AC
120
15
0
13
120
TO USE 12 – 0 – 12V TRANSFORMERS
D5 AND D6 MUST BE REMOVED
TRANSFORMER 20VA MIN (MAPLIN WB25C)

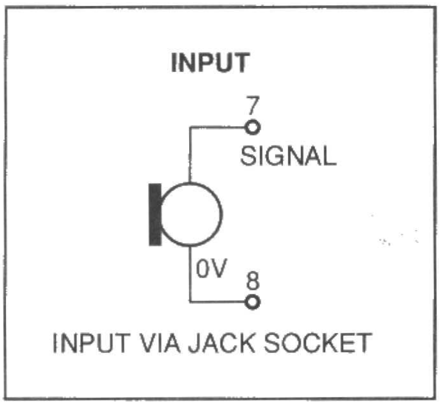
Do not build the box for the project until the speaker or speaker-combination has been selected, as this will dictate the size of the box.

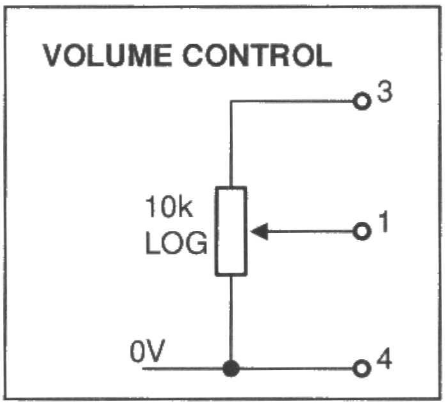
Construction of the box

One easy solution is to use an old loudspeaker cabinet from an obsolete stereo system, as this will have the speaker already mounted, but if it is an 8-ohm speaker the power will be reduced dramatically; a 4-ohm speaker is good, and two 4-ohms are even better. The back panel can then be removed and a metal panel mounted in its place which can hold the input jack socket, volume control, meter and mains switch.

The PCB and transformer can also be mounted onto the back panel as well, care being taken that the transformer is


METER
11
– VE
+VE
10
FOR BEST RESULTS SOME METERS
REQUIRE BACK LIGHTING. IF SO USE
A 14V BULB BEHIND METER POWERED
FROM THE 12V AC FROM TRANSFORMER
NOTE: 12 VOLT OUT FROM PCB NOT SUITABLE





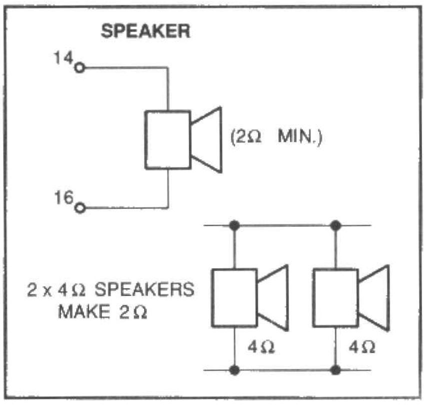


Figure 4a-f: input and output connections to specific components

PARTS LIST

Resistors

All 0.25 W unless otherwise stated

R1	100k
R2, R5	3k9
R3	100k
R4	1M
R6	1k2
R7	680R
R8	See text 18k nom.
R9	220R
R10	2R2
R11	39R
R12	1R
VR1	10k log volume pot.
R13	100k #
R14	4k7 #

Attenuator lead

Capacitors

C1	330n
C2	100n 25V axial
C3	220p disc
C4	82p disc
C5	10u 25V axial or radial
C6	470n 16V radial
C7	220u 25V radial
C8	10u 25V axial or radial
C9	470u 25V radial
C10	220n 35V disc
C11	3.3n poly
C12	47n 25V radial
C13	100n 25V disc
C14,15,16	2,200u 25V radial

Semiconductors

IC1	TDA 2003H (horizontal mount)
Q1, Q2	BC109
D1,2	IN4148
D3,4	INS401 3 amp
D5,6	INS401 3 amp**
ZD1	12V 500mW or 1 watt

** Do not fit if 12-0-12V transformer is used (see diagram)

Transformer	12V 20V A min
Loudspeakers	See text. 2x6 in 4 ohm in parallel
Meter	Any cheap peak of VU audio type
Jack skt	25 standard mono 1 or 2 (see text)
Mains switch	2-pole on/off 250V 2 amp

Ready-built speaker box, or materials to build one.

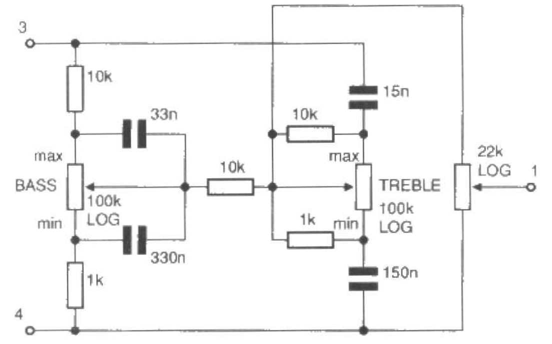
Size and type to suit chosen speakers.

Metalwork to suit. Jackplugs as required.

Heatskink	Details not critical, but the larger the better. Use suitable materials to hand.

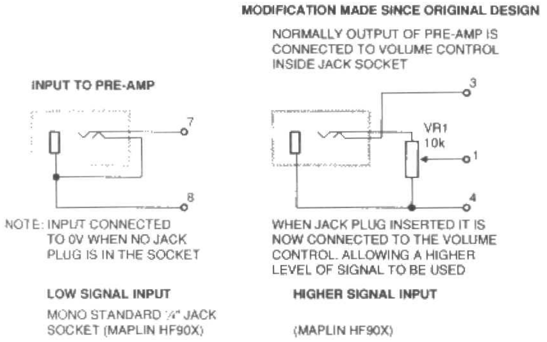
well mounted and there is no risk of the mains wiring touching anything, things can get a little tight. The transformer should be mounted as near to the bottom of the box as possible so as not to be top heavy. A small hole can be drilled for the mains cable and a knot tied inside the cabinet to stop the cable being pulled back out.

If a ready made box is not available one can be made out of MDF (medium density fibreboard). This material come in sheets and 10mm to 12mm thickness will be best. To find the size the speakers should be laid out as in the diagram, there should be a space between the speakers so as to give strength to the front panel. Also there should be enough room all the way round to allow for the batten which will hold the panel in place. To add strength a 25mm x 25mm batten should be fixed to all the inside edges and corners and glued into position. After the round holes for speakers have been cut the front of the front panel should be covered in thin foam rubber about 10mm thick and then sprayed black, the speakers will not show through. Speaker cloth is then used to cover the front of the speaker panel, it should be secured using staples and glue. A weight should be applied to the back of the speaker when doing this so as to keep the foam rubber under tension. When the weight is removed the front of the speaker cloth should be tight and not subject to vibration in use.



ALL COMPONENETS ARE MOUNTED ON THE POT TERMINALS

Figure 5: an external tone and volume control circuit



NORMALLY OUTPUT OF PRE-AMP IS CONNECTED TO VOLUME CONTROL INSIDE JACK SOCKET

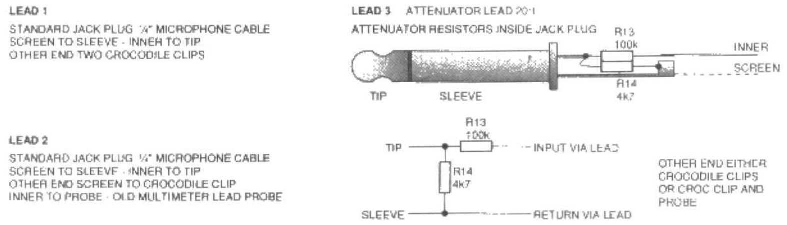
NOTE: INPUT CONNECTED TO 0V WHEN NO JACK PLUG IS IN THE SOCKET

WHEN JACK PLUG INSERTED IT IS NOW CONNECTED TO THE VOLUME CONTROL. ALLOWING A HIGHER LEVEL OF SIGNAL TO BE USED

MONO STANDARD ¼" JACK SOCKET (MAPLIN HF90X)

(MAPLIN HF90X)

Figure 6a and b: Low signal input and a higher signal input mod



STANDARD JACK PLUG ¼" MICROPHONE CABLE
SCREEN TO SLEEVE - INNER TO TIP
OTHER END TWO CROCODILE CLIPS

ATTENUATOR RESISTORS INSIDE JACK PLUG

STANDARD JACK PLUG ¼" MICROPHONE CABLE
SCREEN TO SLEEVE - INNER TO TIP
OTHER END SCREEN TO CROCODILE CLIP
INNER TO PROBE - OLD MULTIMETER LEAD PROBE

OTHER END EITHER CROCODILE CLIPS OR CROC CLIP AND PROBE

Figure 7: input leads and connecting the jack plugs

The speakers are held in position with countersunk bolts through from the front, these go through the speaker fixing holes and shakeproof washers prevent the nuts from coming loose through vibration.

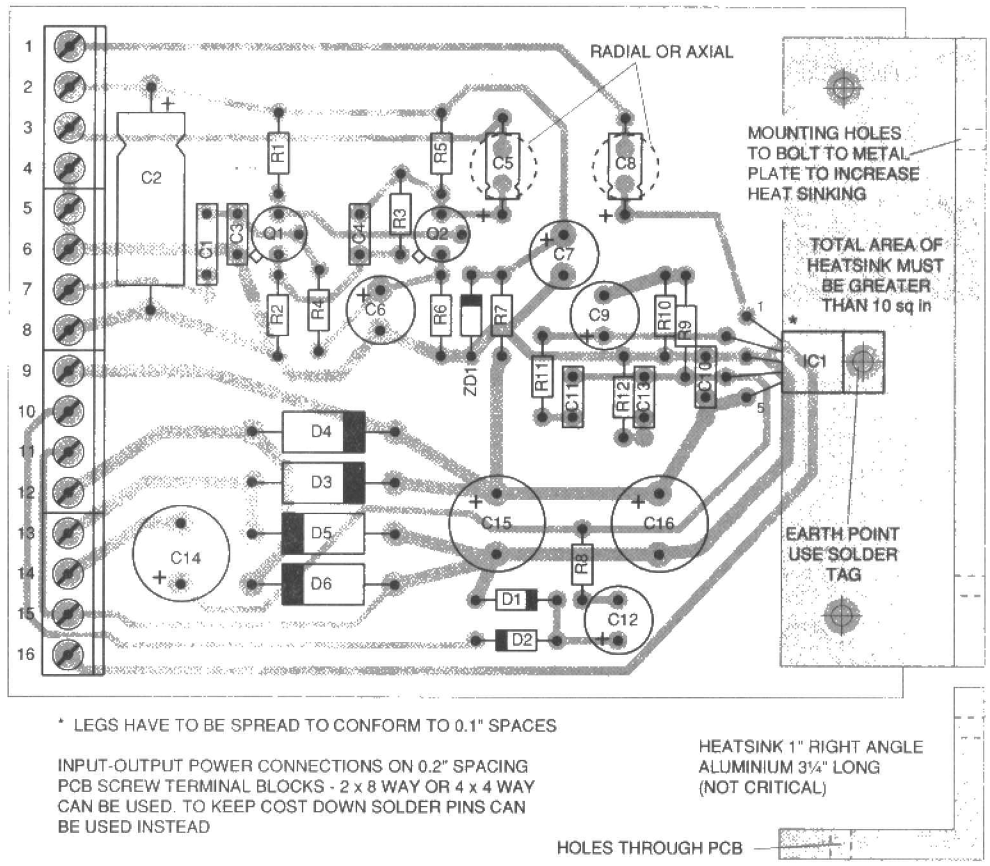
Great care should be taken when testing the Midget because until the box is finally closed there will be live mains exposed on the switch and transformer, although not on the PCB or speakers. Close the case or cover the opening whenever possible.

A jack plug with a co-ax lead is required. A couple of crocodile clips on the other end allow contact to be made to the points being monitored. Always check that the 0V return lead to the Midget is making contact before the signal lead, this limits the hum pick up. A couple of leads can be made, one as stated above. the other having a crocodile clip for the earth and a probe like a meter lead for the signal; this then can be used to make contact on a PCB more accurately than a crocodile clip.

A jack mod

A modification made since the original construction consists of mounting another jack socket, such that with no jack plug in it the output of the pre amp goes to the volume control, but when a jack plug is inserted the connection is broken. Now the volume control is connected to the jack plug and lead enabling a higher level signal to be applied without the volume control being right on minimum. When the jack plug and lead are withdrawn from this socket the circuit is remade via the switched tip contact in the jack socket and the pre amp circuit is connected back to the volume control.

Another way round this is to make an attenuated lead with a 100k resistor in series and a 4k7a resistor across the input of the pre amp, this then reduces the input by roughly 20 to 1.



* LEGS HAVE TO BE SPREAD TO CONFORM TO 0.1" SPACES

INPUT-OUTPUT POWER CONNECTIONS ON 0.2" SPACING PCB SCREW TERMINAL BLOCKS - 2 x 8 WAY OR 4 x 4 WAY CAN BE USED. TO KEEP COST DOWN SOLDER PINS CAN BE USED INSTEAD

HEATSINK 1" RIGHT ANGLE ALUMINIUM 3¼" LONG (NOT CRITICAL)

Figure 8: the component layout for the Mighty Midget

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A High Performance Medium Wave Receiver

In Part 2 of this selective design for Medium Wave, Raymond Haigh describes the construction, setting up and operation of his radio.

Part 2

In the last issue of ETI, we described the High Performance Medium Wave Radio and printed the circuit diagrams and the component layouts for the three main PCBs, as well as a constructional diagram for the special four-gang tuning capacitor (which is described in more detail in this part). The Parts List also appeared in the first part. This month, we round up with information about the specialised components, constructional descriptions of the boards and other hardware, and the testing, alignment and operation of the radio.

To recap on last month, the High Performance receiver here has been specially designed for medium wave, with alterable selectivityto to suit different reception conditions, and signal frequency amplification that can be set manually to achieve the best signal-to-noise ratio. The AGC system acts ahead of the mixer to help to avoid receiver overload. Output is reasonably steady over wide variations in signal input, and I have been very pleased with the audio quality. I employed a modular construction so that constructors could use other audio amplifiers or power supplies if they wish. Suggestions are made ifor simplifying the circuit for those who would prefer to start with a less complicated receiver.

Simplifying the receiver

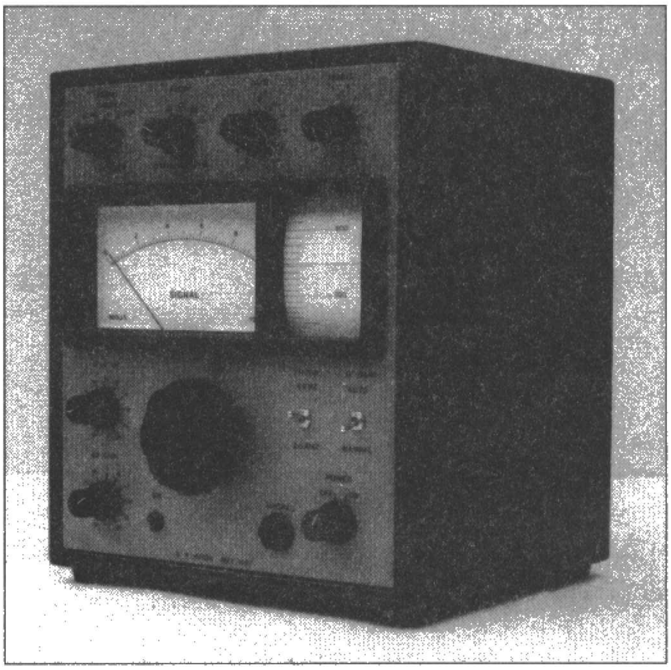
Some of you may not want all the features shown in the circuit diagrams, or you may wish to build a basic radio and add to it later. Constructed as described, this is a very pleasant and effective receiver, but it will continue to perform well if some reductions are made to the specification. The following possiblities are suggested:

(1) Delete the front-end bandpass tuning unit and AGC circuitry, and connect the input attenuator and aerial switching to L3. More care will have to be taken with the attenuator setting when long aerials are used, and the receiver will be more prone to spurious responses.

(2) Delete the 2.6 kHz ceramic filter, the relay and its activating switch, and wire the 4kHz mechanical filter permanently into circuit.

(3) Delete the tone control circuitry and the pre-amplifier stage Q8, and connect C29 to the 'top' of the AF gain control.

(4) Delete the mains power supply and use a pack of eight 'D' cells to power the receiver. R56 will need reducing to 3k9 ohms and R57 should be reduced to 270 ohms. The receiver will function with supply voltages as low as 6V, but the signal strength meter zero adjustment drifts when the voltage falls significantly.



Components

The Toko solid dielectric variable capacitors and plastic spindle extenders are available from Cirkit (Cirkit Distribution Ltd., Park Lane, Broxbourne, Herts EN10 7NQ. Tel. 01992 448899) who also supply the tuning coils, IFTs and filters. The signal switching relay is listed in the Maplin catalogue, and the remaining components are available from many sources.

An inexpensive speaker is to be preferred, and it should be as large as your cabinet space permits (a 200 x 130mm unit is fitted in my prototype). Please note that hi-fi speakers can be insensitive, and should be avoided.

A signal strength meter of reasonable size will be helpful, when setting a loop aerial, to check the bearing of a transmitter. An 120 x 90mm unit is installed in my prototype.

Brass strip for the tuning capacitor linkage is sold in most model shops and is also listed in the Maplin catalogue. Steel shaft needed to ensure the perfect alignment of the capacitor couplings is sold by most large DIY outlets.

The tuning capacitor assembly

The four-gang tuning capacitor is made up from two x polythene dielectric variables. These units have a very low minimum capacitance and this makes it easy to extend the coverage of the receiver to above 1700kHz.

Figure 2 and the photographs give a view of the arrangement. The tuning capacitors are mounted on small PCBs which are fixed

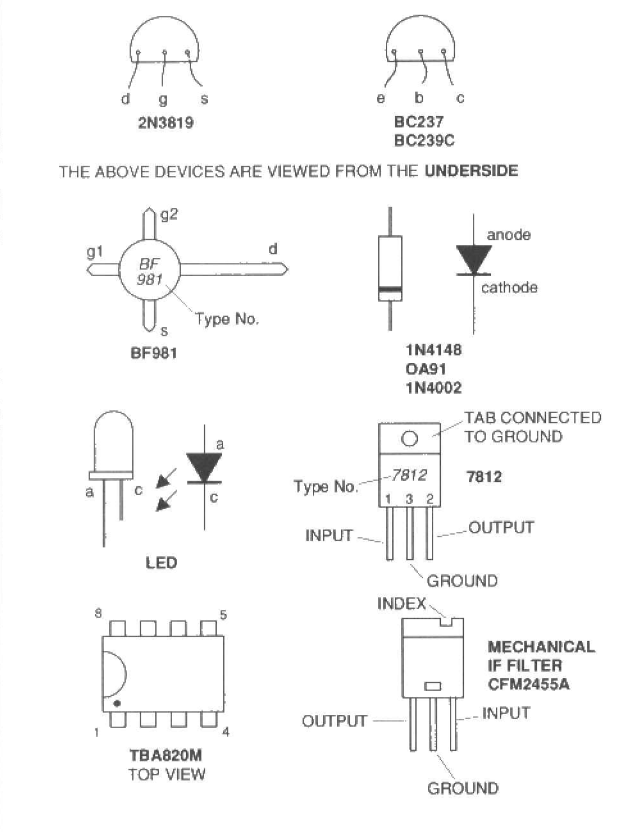


Figure 7: semiconductor and IF filter lead connection details

at right angles to the main receiver PCB by aluminium brackets. The plastic spindle extenders are connected by brass spindle couplers. Experienced users can use a gas stove or plumber's blowtorch to heat the items if a heavy duty soldering iron is not available.

Slide the couplers and the cranked brass strip onto a length of 6.3mm diameter steel shafting, then re-heat the items to sweat them together. The steel shaft ensures the perfect alignment of the coupling system.

Mount the capacitors onto the small PCBs with their three-tag-side towards the bottom, and fit Vero pins at the lead-out points. Fix the capacitor PCBs to the brackets with 8BA nuts and bolts.

Loosely bolt the brackets to the main PCB. Slide the coupling system onto the plastic spindle extenders, check the entire assembly for perfect alignment, and then tighten the fixings to the main PCB.

Set both capacitors at minimum, position the cranked arm, then tighten the grub screws in the spindle couplers. The assembly is now complete.

Trimmer capacitors are included in the tuning capacitor casings, but they are difficult to access with this arrangement, and separate trimmers are mounted on the PCB.

The solid dielectric capacitors are inexpensive, closely matched, and function well in this application. Some constructors may, however, wish to use air-spaced variables, and there is just sufficient space on the PCB for two Jackson Type O twin-gang capacitors. This alternative was not tried during the development of the receiver, but it should work well and it should still be possible to extend the coverage to 1700kHz, despite the increased minimum capacitance (10 instead of 5pF). The dimensions of the cranked brass strip may need changing slightly. Jackson capacitors are retailed by Cirkit and Maplin.

Constructing the RF, IF and detector circuits

With the exception of the switches, the signal strength meter, and R1 - R9, all of the parts are assembled on a printed circuit board. The layout of the components is given in figure 3. Vero pins, inserted from the component side of the board, soldered to the copper side and then cropped, can be used to form connection points for the dual gate mosfets, Q2, 4, and 5. It is a good idea to re tin the heads of the pins, and to grip the leads of the devices with metal tweezers during the soldering process.

Mounting these transistors in this way, rather than by soldering them to the copper tracks, permits removal without the need for access to the underside of the board.

Note that Q2 is located with its type number towards the PCB. Q4 and 5 have their type numbers uppermost. The 2.6kHz filter is orientated by means of the soldering tag on its can. The 4kHz filter has an indentation in its plastic case.

With this and the other PCBs, Vero pins inserted at the lead-out points will simplify the task of off-board wiring, and the use of IC sockets for the relay and IC1 will make it easy to check these components by substitution and avoid any resoldering.

The aerial switching and attenuator circuit

The attenuator resistors are mounted directly onto the tags of S1. Figure 4 gives details of the arrangement, and also the wiring between the aerial selector switch and the receiver. The tag identification numbers and letters in this figure correspond with those on the specified Lorlin switches. Try and keep the wiring to the short aerial socket as distant as possible from earthed components, to avoid placing too much stray capacitance across L1.

A DIN plug and socket are suitable for the loop aerial connection.

The audio amplifier

Again, most of the parts are mounted on a PCB, and the component side is illustrated in figure 5. Bass, treble and AF gain controls are, of course, located on the front panel of the receiver. Use screened leads between the sliders and the "hot" ends of these controls and the PCB, and connect the metal cases of the potentiometers to the 0V rail via the screening braid.

The loudspeaker is connected to +12V as this results in some economy in components. With this arrangement, it is wise to isolate the speaker chassis from the 0V rail.

The power supply

Readers who have no experience of building or commissioning mains-powered equipment (as per our publisher's normal warning!) should note that the voltages involved are lethal. Extreme care must be taken when building and testing this part of the circuit, and if the constructor has any doubts about his ability he should use batteries to power the receiver.

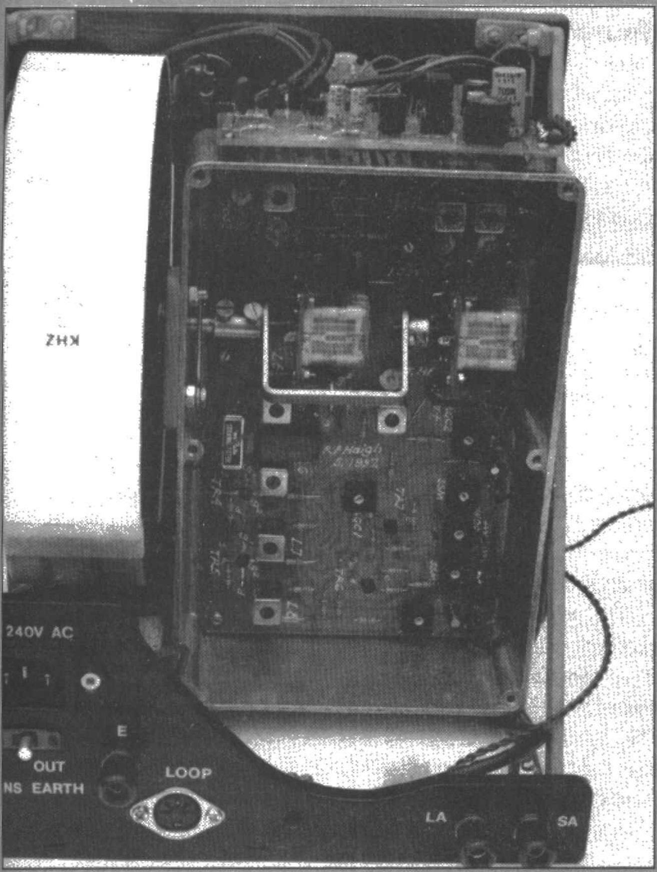
The component side of the power supply board is shown in figure 6. Provision is made for both axial and radial lead versions of the large reservoir capacitor C47. If the board must have the lowest possible profile to suit your particular cabinet layout, choose an axial lead component.

A heat sink must be fitted to the regulator IC - any one designed for a TO220 package will be suitable.

The use of a Euro style inlet plug and line socket to connect the unit to the mains supply is a wise safety feature.

Initial testing.

The PCBs can be wired up on the bench for initial testing and alignment before being mounted in a cabinet. First of all, check the boards for poor soldered joints or bridged copper tracks, check the orientation of all semiconductors, polarised capacitors (electrolytic



and tantalum), and filters. Set all potentiometers to mid travel. Do not connect the signal strength meter at this stage.

With the power supply output disconnected from the equipment, switch on the mains supply. The voltage across reservoir capacitor C47 should be approximately 23V. The voltage at the regulator output should be precisely 12V. Connect the 12V output to the RF, IF and detector board. Current consumption should be of the order of 10mA. Actuating the filter relay should make current consumption rise to around 40mA. Series resistor R57 limits the voltage across the specified relay coil to about 8V.

Connect the audio amplifier. Under no-signal conditions, current consumed by this part of the circuit is approx. 12mA. When music is reproduced at good volume, current rises to around 100mA.

Setting up and alignment

While it should be possible, with care and patience, to bring the receiver into a reasonable state of alignment without a signal generator, it will not be possible to optimise its performance. Guidance on alignment will, therefore, assume access to a simple signal generator. A multimeter, preferably a high-impedance digital or electronic model, will also be required. Some advice on aligning the receiver without a signal generator is given later for constructors who wish to try.

Before attempting the setting-up and alignment process, it is as well to remember that the HF tuning limit is mainly determined by the setting of oscillator trimmer C15, and that LF coverage is controlled largely by the setting of the oscillator coil core (L4). The oscillator must run at 455kHz above the signal frequency tuned circuits over the entire tuning range. This is achieved by using an oscillator coil of lower inductance than the signal frequency coils, and by placing a padder capacitor C16 in series with the oscillator tuning capacitor C18 to reduce its swing. The optimum value of the padder is related to the inductance of the oscillator coil, and C17 is included so that the padder can be adjusted slightly.

With modulation switched on and the signal generator output kept as low as possible all times, proceed as follows:

(1) Switch in the manual IF gain control and set it to half travel. Set the AF gain control to half travel also. Apply a 455kHz signal to the drain of the mixer Q2, and adjust the cores of the IFTs for maximum response in the loudspeaker. The IF is determined by the filters and not the signal generator, so rock the generator output gently around 455kHz to ensure that it is set to the required frequency. If the transformer cores are so out of position that alignment proves elusive, apply the signal to the drain of Q5, adjust the core of IFT4 first, and then work back. This was not found to be necessary with either of the two prototype receivers.

(2) Connect a multimeter reading 0 - 1mA to the signal strength meter output, set the slider of R32 to the meter end of the potentiometer, and set R31 to minimum resistance. Adjust R36 to zero the meter pointer. Connect up the signal strength meter, or switch the multimeter to a range in the 50 - 100uA region, and refine the zero adjustment.
(3) Inject a 455kHz signal at the drain of Q2. The meter should swing over. Increase the value of R31 to reduce the reading and reduce the setting of the IF gain control, as necessary. Switch in the 2.6kHz filter and use the visual indication of signal strength to refine the adjustment of the IFT cores. Final adjustments to peak the response will be quite critical.

(4) Switch IF gain control to automatic, connect the testmeter across the IF AGC line, and adjust R38 to give a reading, under no-signal conditions, of 4V. (If a meter of only moderate sensitivity is used, set the reading to, say, 3.5V to allow for the shunting effect.) The precise setting is not excessively critical. Inject a 455kHz signal at the drain of Q2. The AGC voltage should drop almost to zero if the signal is sufficiently strong.

(5) Connect the testmeter to the slider of R12, and set the potentiometer to give a reading of 1V (a little less if a low sensitivity instrument is used). Set R13 for maximum input to the gate of Q1.

(6) Set all trimmer capacitors to half-mesh, set the tuning capacitors to the fully open (clockwise) position, connect the signal generator to the low-impedance primary on L1, and sweep it around 1700kHz until a note is heard in the speaker and the signal strength meter kicks. Adjust the trimmer capacitors (but not C17) to peak the output, gradually opening out oscillator-stage trimmer C15 if necessary, to bring the peak above 1700kHz.

(7) Fully close the ganged tuning capacitors, inject a 480kHz signal, and adjust the core of L4 until the meter pointer rises. Adjust the cores of L1, L2 and L3 to peak the output. The receiver is now in a state of approximate alignment and, if an aerial is connected, signals should be heard as it is tuned across the band.

(8) Check that the tuning range still extends to 1700kHz or above, opening out C15 a little more, if necessary, to restore coverage, and adjusting the trimming capacitors to peak alignment.
(9) The tracking of the oscillator and signal frequency circuits must now be optimised. Set the signal generator to 900kHz and tune the receiver to this frequency (the ganged tuning capacitors should be at about half-mesh). Adjust the cores of L1, L2 and L3 to peak output. Set the generator to 600kHz, and tune in the signal. Gently rock trimmer C10 to establish the state of the tracking. If reducing the value of this trimmer increases output, the padder capacitance is too low and C17 must be increased in value. If increasing the value of C10 increases output, the padder capacitance is too high and the vanes of trimmer, C17, must be opened slightly. Make any

necessary adjustments to the cores of L1, L2 and L3 to peak output at the 600kHz tuning setting.

(10) Set the generator to 1500kHz and make any necessary adjustments (they should only need to be slight) to C1, C5 and C10 to peak output. Do not make any further adjustments to oscillator trimmer, C15, unless HF coverage has fallen below the 1700kHz limit (most unlikely).

(11) Repeat the check on tracking described in (9), above, refining the adjustments until no further improvement can be obtained and alignment is close to perfect at 600, 900, and 1500kHz. A check at other points around the dial should reveal that changing the setting of the cores and trimmers does not produce any significant improvement in response.

(12) If it proves difficult to optimise the tracking (most unlikely), reset the oscillator coil core and try again (coverage need not go below 510kHz or so). Note that instability will probably be encountered if the core is driven too far down as this will permit the receiver to be tuned to its IF.

Alignment without a signal generator

(13) Turn the IF and AF gain controls up to maximum, connect an aerial to the 'hot' end of L3, and adjust the IFTs for maximum noise in the speaker. It should now be possible to tune in a strong signal. If not, adjust the core of L4 until a station can be heard at some setting of the tuning capacitors.

(14) Make the signal strength meter operational, all as described in (2), above, and use it, and the incoming signal, to refine the adjustment of the IFT cores.

(15) Tune in a station as close as possible to the HF end of the band, and adjust C1, C5 and C10 to peak output. Tune in a station at the LF end of the band and adjust the cores of L1, L2 and L3 to peak output. The receiver should now be quite responsive.

(16) Use a known transmission to set the oscillator coil trimmer C15, so that the HF tuning limits are around 1700kHz. (In the UK the handsets of cordless 'phones operate on channels between 1600 and 1800kHz). Use a known transmission at the LF end of the band to set the core of the oscillator coil. (Try Spectrum International from Crystal Palace, London, on 558kHz, or RTE from Tullamore, Ireland, on 567kHz).

(17) When the coverage has been set, use steady transmissions to carry out the procedure described in (9), (10) and (11), above. Care and patience will be required but, with the aid of the signal strength meter, it should be possible to bring the receiver to an acceptable state of alignment.

Tuning drive

Enhanced selectivity makes the adjustment of the tuning control more critical than usual, especially when the narrow filter is switched in and one or other of the sidebands is being selected. Some form of reduction drive is, therefore, essential. A tuning knob of decent size and a slow-motion drive with a reduction of at least 6:1 should be considered minimum requirements. Connecting two epicyclic drives in tandem to give a 36:1 reduction, or using a cord drive and drum salvaged from an old receiver, are better alternatives.

Housing the receiver

Unscreened, the receiver is sufficiently sensitive to pick up a number of stations without an aerial connection, and some form of metal enclosure is desirable, at least for the RF, IF and detector board, or signal nulling with a loop aerial will be impaired. The input attenuator and aerial selector switches should be mounted as close as possible to the input point on the PCB to avoid unwanted signal pick-up.

The arrangement adopted for my prototype is indicated in the various photographs. The RF and IF PCB is enclosed in a die cast box, and the entire receiver is assembled behind a plywood front panel. The tuning dial is wrapped around an 170mm diameter drum built up from fibreboard disks, to which is secured a hardboard pulley for the cord drive. Whatever dial and drive system is adopted, take care not to impose excessive loading on the bearings of the tuning capacitors, and fit end stops to prevent any stressing of the moving parts. The loudspeaker faces rearwards, and large vents, formed in the sides of the cabinet, ensure a clear pleasant tone, which is free from 'boxiness'.

This arrangement enables an easily read dial, a large signal strength meter, and a speaker of decent size, to be accommodated in a cabinet measuring 250 x 220 x 190mm. The front panel is finished with car spray paint and annotated with rub-down lettering. The plywood case is stained and French polished. The bezel which links the dial aperture and the signal strength meter is cut from hardboard and sprayed mat black.

Not all constructors will have the time, inclination or resources to house the receiver in this traditional way, and one of the stylish metal enclosures retailed by component suppliers would do just as well. It would also be cheaper if the construction and finishing materials are not to hand.

Final adjustments

After the receiver has been enclosed in a cabinet, carry out a last check on the alignment and make any final adjustments.Adjust R31 to fix the sensitivity of the signal strength meter, and set R32 to prevent the strongest signals driving the pointer against the end stop. Carry out any last adjustments to the AGC system pre-sets, and the pre-sets which control AF gain (R33 and R54), in order to make the 'feel' of the receiver suit the operator.

Calibration

On medium waves it is not too difficult to calibrate a receiver dial by tuning in transmissions of known frequency. However, a quicker and less tedious method is to use a crystal calibrator. The dial of the prototype receiver was marked out with a unit of this kind which has outputs at 1MHz and 100, 50, 25 and 10kHz. A signal generator can, of course, be used, but the accuracy of calibration will be limited to that of the generator.

Operating the receiver

The receiver can be used with short (up to, say, 3 metres); long (10 metres plus); and loop aerials; It is a good idea to try all three and using S2 to select the one that performs best. Listeners with back yards several hundred metres long could try a Beverage aerial: details of these are given in relevant textbooks. Earthing the receiver via a 1 metre length of copper pipe driven into damp ground usually improves reception. The mains earth can be used, but may introduce electrical interference. Test for this by switching it in and out with S5.

Under normal conditions, the selectivity provided by the 4kHz filter is perfectly adequate. Reducing bandwidth by switching in the 2.6kHz filter will, however, greatly improve reception when electrical noise is severe. This narrower filter will also eliminate co-channel interference (splatter), and enable the receiver to be tuned to either the upper or lower sideband when attempting to resolve 'difficult' signals. It is, of course, particularly useful when picking out transmissions that are close to the noise floor, or weak signals tightly sandwiched between strong ones, Turning down the bass and treble controls can also improve the clarity of signals that are overlaid by noise.

The receiver is reasonably immune to overload, but if a very long aerial is connected and the problem is encountered on strong signals, use the attenuator to reduce input. Switching in the manual IF gain control makes it possible to optimise the receiver noise factor, and inter-station noise when tuning across the band can be largely eliminated when maximum sensitivity is not needed.

Performance

Instruments capable of measuring the sensitivity, selectivity, dynamic range and other parameters of the medium wave radio were not available. It was, however, possible to directly compare it with a high-performance, multiple-conversion communications receiver.

The test was carried out in a town-centre location, not much more than 1km away from the 70m mast of a commercial radio station operating at 250W, and where man-made electrical interference is often severe. A long (30m) aerial was switched between the two sets during the comparison test, which involved the receivers being carefully tuned, in step, across the band, over the period of a summer afternoon and evening.

All of the stations picked-up by the communications receiver could be resolved by the dedicated medium wave radio described here. Indeed, several signals that were lost in noise with the communications receiver could be heard clearly on the medium wave set.

There were no overloading problems, even with IF gain switched to automatic and the input attenuator switched out. (Most simple receivers are badly overloaded by the local transmitter when a 30 metre long aerial is used.)

The medium wave radio did not have any discernible image responses. Only one heterodyne was evident, located close to twice the IF, that is, 910kHz. It could be tuned to zero beat with the incoming signal and did not spoil reception. There were neither images nor heterodynes with the communications receiver.

The above results would seem to confirm the view that, at medium frequencies, a single conversion superhet with good front-end selectivity can outperform more complex communications receivers.

A future aerial

In a future issue we will be describing a Medium Wave loop aerial, designed with Medium Wave radio very much in mind.

MODMODMODMODMODMOD

There are two small errors in the drawings in Part 1: in figure 1a, page 34, the Aerial Selector, the left hand connection from S2A to the Loop Aerial is shown wired to terminal 1 of S2A; it should be wired to terminal 3 of S2A. That line is shown correctly crossing the Ground line. The middle connection from the Loop Aerial to terminal 1 of S2B is connected correctly at each end, but should also be shown connected to the Ground line (the crossing point should be marked with a dot), unlike the other two lines from the Loop Aerial.

In figure 1b, page 35, on the far right, the line from D4/C2 is shown crossing the line between R26/R27: it should be connected to it. (That is, the crossing point should be marked with a dot. The PCB foils are correct.

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Fast Fivers

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7. Animated light starburst

This is a 'animated' light display. Hang it on the wall, fix it to the front door, or suspend it from a Christmas tree. It features an array of 25 LEDs, arranged in three concentric circles, with a jumbo-sized LED in the centre. The display runs through its sequence about once a second. First the central LED comes on - the star. Then it 'bursts' - the star goes out and the concentric circles light up one at a time, starting with the inner one, then the middle one and finally the outer one. After a short period of darkness the sequence begins again. The effect is as if the star bursts and an explosive wave of light spreads outward from it.

Although this is described as a fast Fiver, it is fast only in the sense that the display runs rapidly. There is rather more wiring in this one than has been usual in this series (figure 1). This project will give you 2 or 3 hours of fun in assembling it, yet costs less than £5 (if you shop around). It also offers you scope for your own ingenuity in modifying the design. And, not least, it is a decorative object to be brought out every festival for several years ahead.

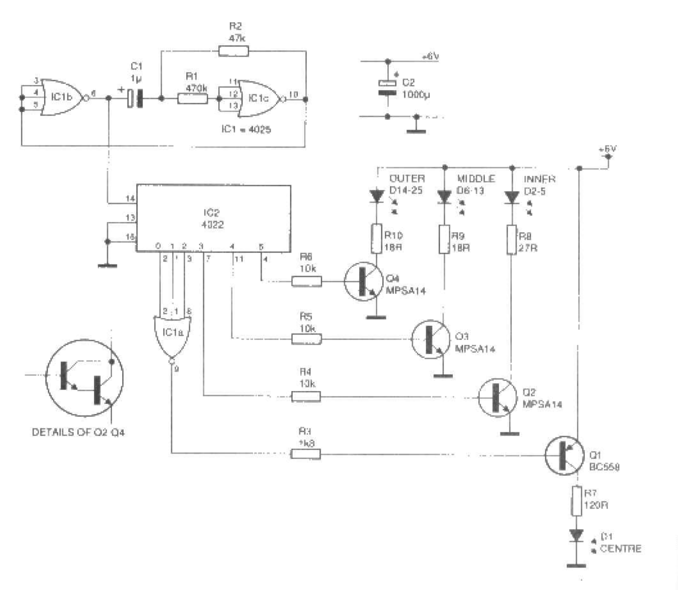
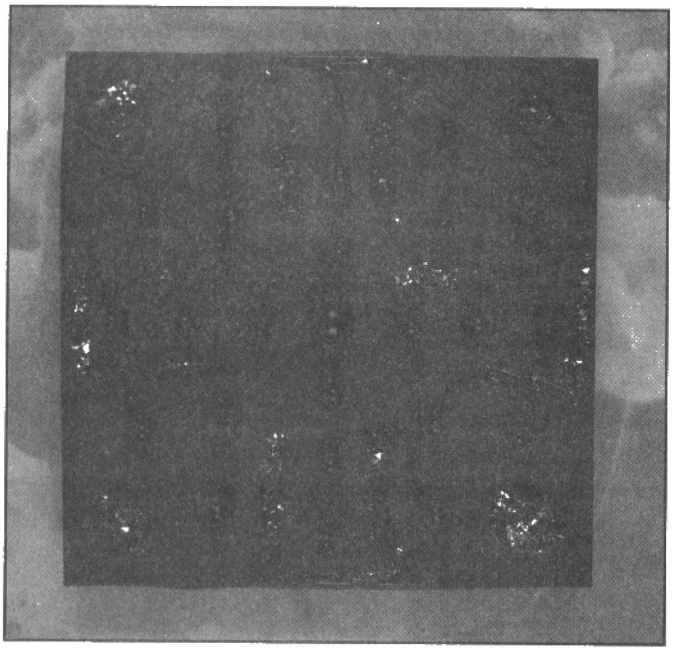
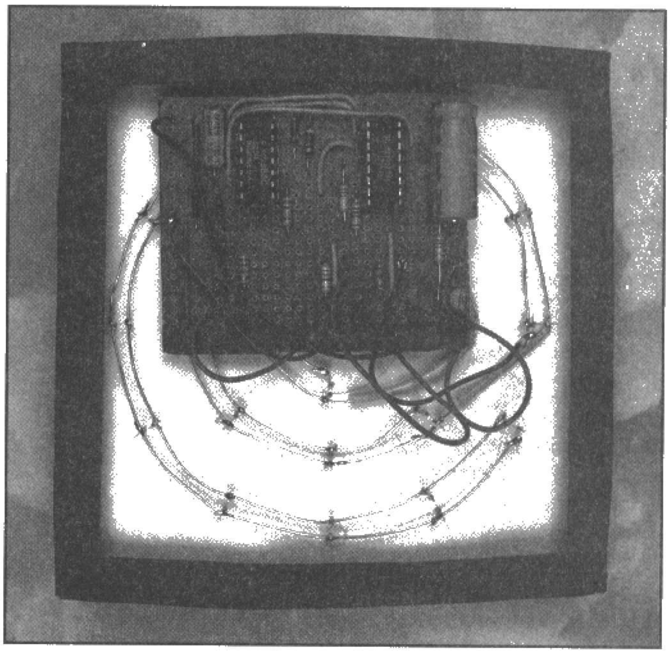


Figure1: the Starburst schematic

How it works

The circuit is driven by a clock built from two 3-input NOR gates. We employ these gates instead of the usual simple inverters because we need a single 3-input gate for the programming logic. With the values given in figure 1 the clock runs at about 10Hz. The output from the clock goes to IC2 which is a divide-by-eight counter with 1-of-8 outputs. It has 8 outputs (numbered from 0 to 7) which are normally low (0V). As the counter is clocked, the outputs go high (6V) one at a time, in numerical order. The result of





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this is as follows:

1 For the first 3 counts, output 0 goes high, followed by output 1 and output 2. If any one of these is high, the output of the NOR gate (IC1a) is low. At all other times it is high. When it is low, it turns on the pnp transistor (Q1) and current flows to D1, which is the large LED in the centre of the display. So this LED is lit for the first 3 counts and is dark for the remainder.

2 For the next 3 counts, outputs 3, 4 and 5 go high in turn. These turn on transistors Q2, Q3 and Q4 one at a time. Actually these are not simple transistors, even thought they are drawn as such in figure 1, which shows that the MPSA14 contains two npn transistors connected as a Darlington pair . The emitter current of the first transistor flows to the base of the second transistor. The gain of the pair of transistors is the product of their individual gains. This gives Darlington transistors gains of the order of 5000 to 10000, compared with only 100 for a typical single transistor. We have used Darlingtons here so that the small current (0.44mA) available from the cmos outputs of IC2 are able to switch the rather large currents flowing through the LEDs. Allowing 20mA per LED, the inner circle of four LEDs needs 80mA, the middle circle (eight LEDs) needs 160mA and the outer circle (twelve LEDs) needs 240mA.

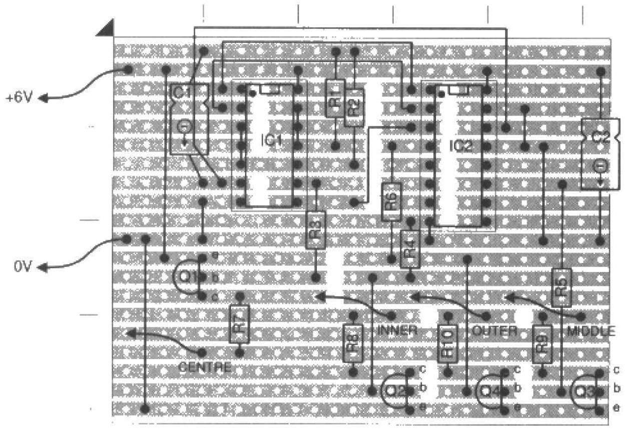


Figure 2: the Starburst stripboard layout

For the final two counts of the 8-stage sequence, outputs 6 and 7 go high but, as there are no connections to these, the display goes dark in preparation for the next 'burst'.

Construction

This circuit requires an average current of a little over 60mA and it is likely to be run for several hours at a time. The most appropriate power supply is a 6V DC plug-in mains adapter unit. A 300mA unregulated one would be suitable. If you prefer batteries, the best sources are a 6V 'lantern' battery (HP992) or a battery holder with 4 size D cells.

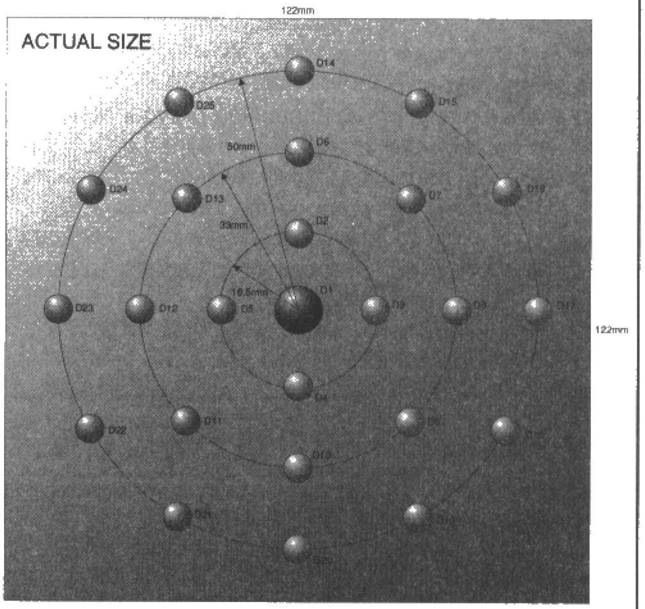


Figure 3: the Starburst display panel with dimensions in millimetres

The stripboard layout (figure 2) is compact so that the board can be small and easily concealed behind the display. For this reason, the various subcircuits are more mixed up than usual, so take special care that the wire links and resistors are soldered into the correct holes. Solder in the sockets for the two ICs first, together with R1, R2, C1, all the wire links and the terminal pins at B1 and L1. Note that the copper strips are cut beneath the board at C8 to F8, H8, J8, C14 to J14, C18 to K18, M12 to O12, P17, P22, S17, S22, T17, and T22. Solder blobs are used to bridge adjacent strips, joining: E8 to F8 to G8, B10 to C10, D10 to E10 to F10, K17 to L17, and B20 to C20. Insert the ICs in their sockets, apply power, and use a test meter to check that the clock is running. Also test the outputs of IC2 and the output at pin 9 of IC1 to confirm that output signals are as expected.

Now add the large capacitor (C2), which is provided to smooth out spikes on the power lines produced when large numbers of LEDs are switched on or off simultaneously. Without this smoothing, the counter operates erratically. Complete assembly by soldering in the

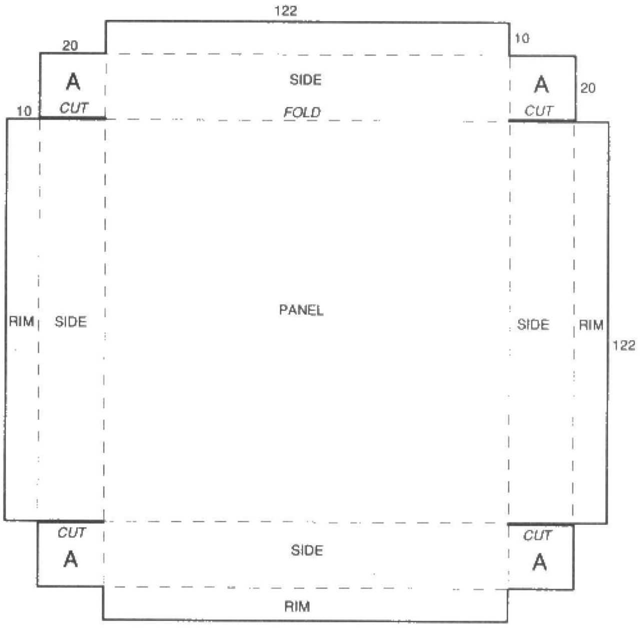


Figure 4: the Starburst - a pattern for a cardboard case/panel

transistors (Q1 is the pnp transistor) and the remaining resistors and terminal pins.

The display

This can take many forms, depending on your taste and skills, but we describe the one we designed as a decoration to hang on the Christmas tree. It does not have room for a battery. We wrapped the battery up in Christmassy paper to look like a 'present' and lodged it firmly in the fork of one of the lower branches, with wires running to the hanging display.

It is worth mentioning at this stage that this circuit could be the basis of a large-size 'Piccadilly lights' display. If you have experience of mains wiring, you can replace the groups of LEDs with four relays rated to take mains current. Then these relays can be used to switch banks of mains-voltage lamps.

The LED display panel (figure 3) is the bottom of a square shallow box made from thin card (we used red). Later you can decorate the surface of the box with tinsel or 'glitter' or in any other way that appeals to you. The sides of the box are 20mm deep to allow room for the wiring and circuit board, and there is a 10mm rim around the top edge of each side to stiffen the sides. First mark out the pattern of (figure 4) on the thin card; make cuts where indicated and score along the dashed lines. Fold up the sides and glue the flaps marked A to adjacent sides, to form the box. Leave the rims until later. You now have a box 122mm square and 20mm deep. The panel needs stiffening from behind (that is, from inside the box) so cut out a 120mm square of thick (1.5mm - 2mm) cardboard. You could instead use plastic-board, hardboard or plywood. Mark this out to show where the LEDs are to go (figure 5). The LEDs are to be in circles 16.5mm, 33mm and 50mm radius, so draw circles that are 1.5mm larger and smaller than this to show where to prick the holes for the LED leads. Across these draw radii spaced 90 degrees apart on the inner circles, 45 degrees apart on the middle circle and 30 degrees apart on the outer circles. There are also two holes to be marked in the centre, spaced 3mm apart for the jumbo LED. Now coat the back of the card evenly with glue and drop it into the box (it is a loose fit). Let it dry under firm pressure. Use a stout pin to prick through all the points where the circles intersect the radii (the dots in (figure 5). If you are using hardboard or plywood you will need a fine (0.8 or 1mm) drill for this.

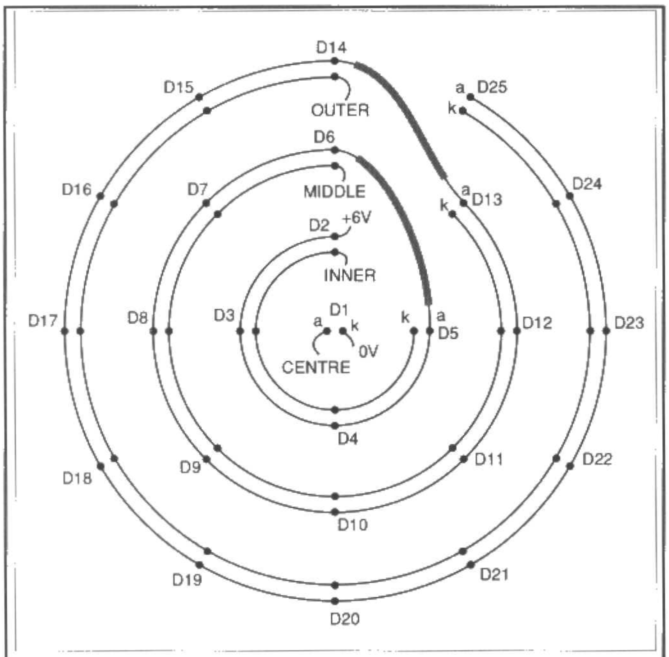


Figure 5: wiring the panel, as seen in rear view

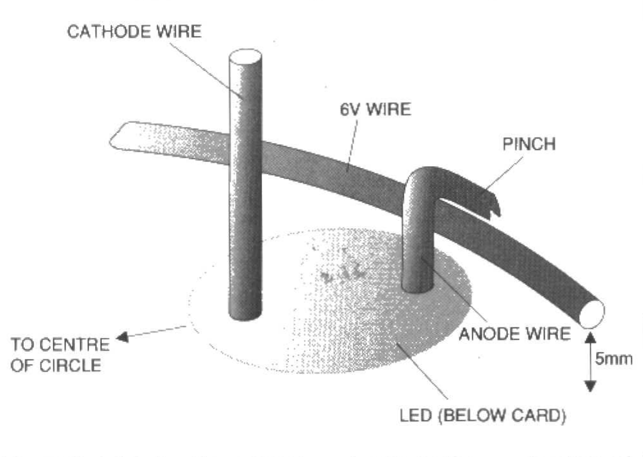


Figure 6: soldering the power supply wire to the anode wires of the LEDs

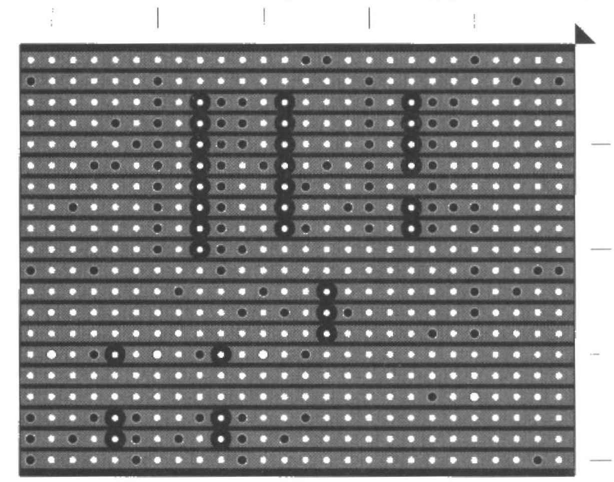


Figure 7: the back of the stripboard layout

Insert the 12 LEDs in the holes for the outer circle. If you like, you can give the base of each LED a drop of glue to fix it to the panel, but this is not essential as the wiring helps to hold the LEDs in place when it has been soldered. Check very carefully that the LEDs are arranged with their anode wires through the holes in the outermost circle. With most (though not all) makes of LED this means that the 'flat' on the rim of each LED faces toward the centre of the circle. Strip a 350mm length of single-stranded connection wire, which is to be the +6V supply wire. Beginning at D25, solder it to the anode (a) wires of D25 to D14. Before soldering, cut each terminal wire of the LED so that it protrudes about 8-10mm from the card. Bend the end of the anode wire over the supply wire and pinch it tightly (figure 6). This leaves a few millimetres between the supply wire and the card so that you can grip the anode with a heat shunt. This is a precaution against damaging the LED while soldering. Apply a small amount of solder to the joint, making sure it flows on to both the anode wire and the supply wire. Repeat this procedure with a second wire joining the cathode wires (k) of the LEDs. You now have 12 LEDs wired in parallel.

It is worth while to check the connections as you proceed so, when you have finished the outer circle, connect the supply wire to +6V, temporarily connect an 18-ohm resistor to the cathode wire and the 0V supply to the other end of this resistor. All LEDs should light up brightly. If any fail to do so, check the soldering and also re-check that the LEDs are the right way round. Repeat the above operation of soldering and testing for the middle and inner circles. Solder connections to join all the power supply wires together, as shown in figure 5. Use insulated wire, or wire covered by plastic sheathing. Connect the other wire ends and also the terminals of the jumbo LED to the terminal pins on the circuit board, using light-duty multistranded wire. Note that Q2, Q3 and Q4 are NOT in numerical order on the board.

At this point the circuit is ready for its final testing, with the circuit board not yet placed inside the box. Just switch on and watch the display burst about once a second. Now fix a piece of double-sided adhesive foam ('Sticky Fixer') at each corner of the circuit board on the copper-strip side. Cut a rectangle of thin card the same size as the board and press this on to the under-surface. This is to prevent short-circuits between the board and the base wiring. Fold the rim strips inward, overlapping at the corners and glue them together there. Tuck the circuit board under one rim; this is not a very secure fastening but adequate for most purposes.

To complete the project you may like to add some form of decoration. Perhaps cover part of the panel with glue and sprinkle coloured glitter on it. Add a few strands of tinsel and in any other way you like add sparkle to its bursting brightness.

PARTS LIST for the Starburst

Resistors

All 0.25W, 5 percent tolerance

R1	470k
R2	47k
R3	1.8k
R4 - R6	10k
R7	120R
R8	27R
R9 - R10	18R

Capacitors

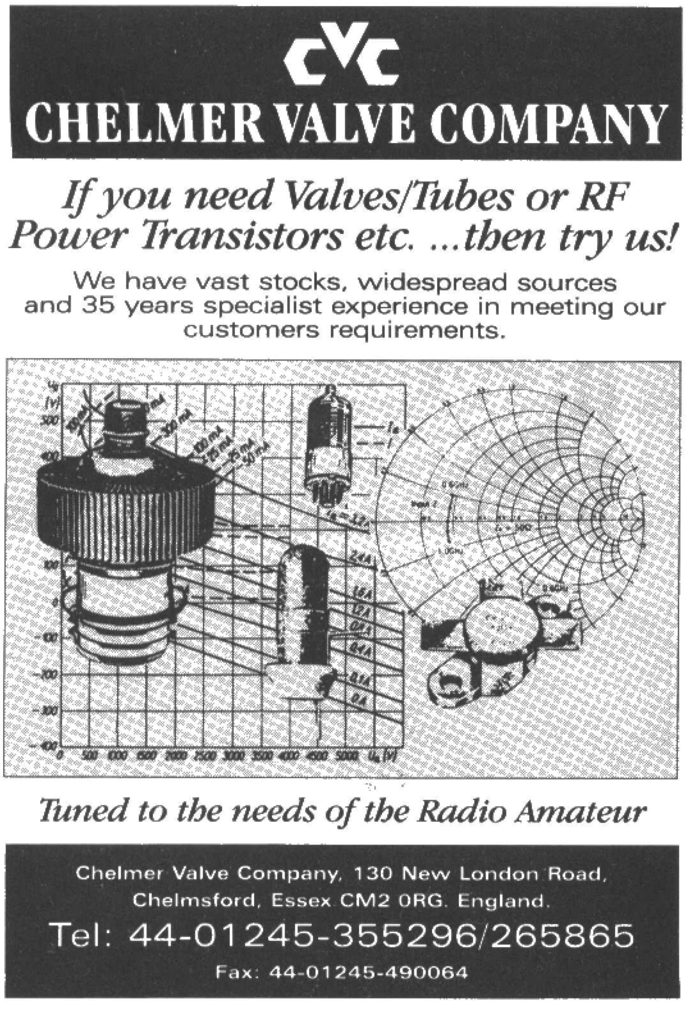
C1	1uF axial electrolytic
C2	1000 uF axial electrolytic

Semiconductors

D1	10mm LED
D2 - D25	5mm LED (24 off)
IC1	CMOS 4025 triple 3-input NOR gate
IC2	CMOS 4022 divide-by-8 counter with 1-of-8 outputs
Q1	BC558 pnp transistor
Q2 - Q4	MPSA14 npn Darlington transistor (3 off)

Miscellaneous

Stripboard 52mm x 68mm (20 strips x 26 holes); 1mm terminal pins (6 off); 14-pin dil ic socket, 16-pin dil ic socket; materials for making and decorating display box.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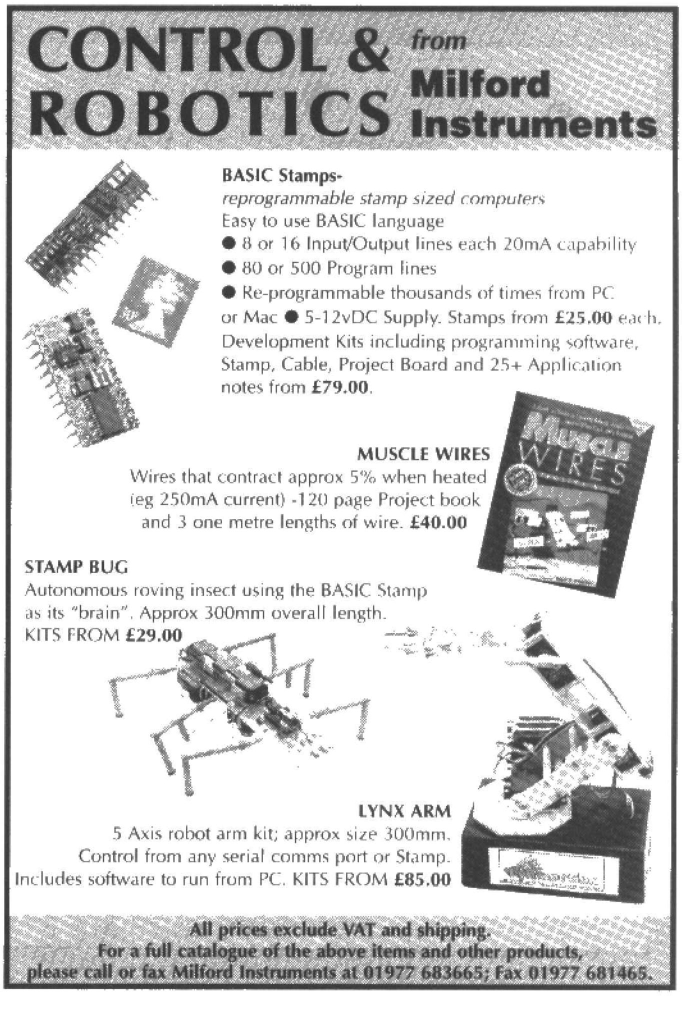
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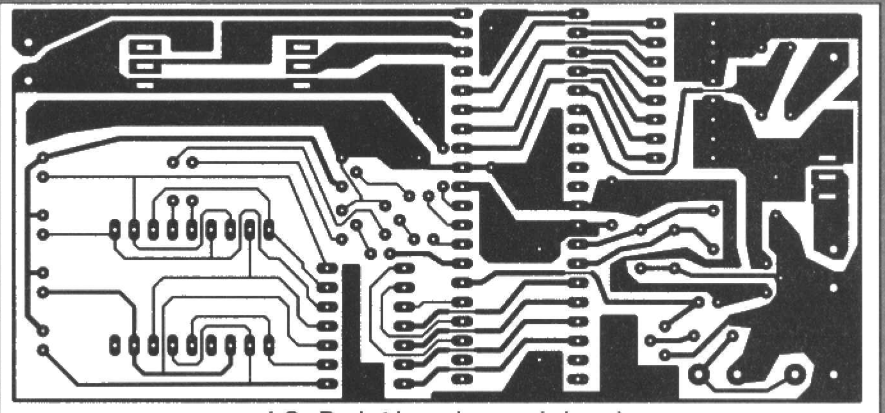
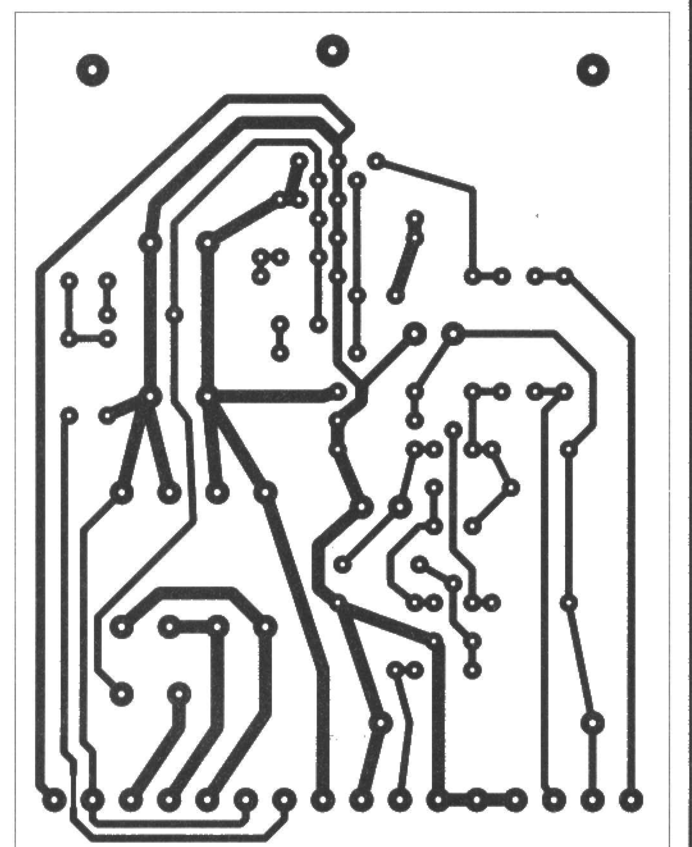


4-Go Rocket Launcher - main board



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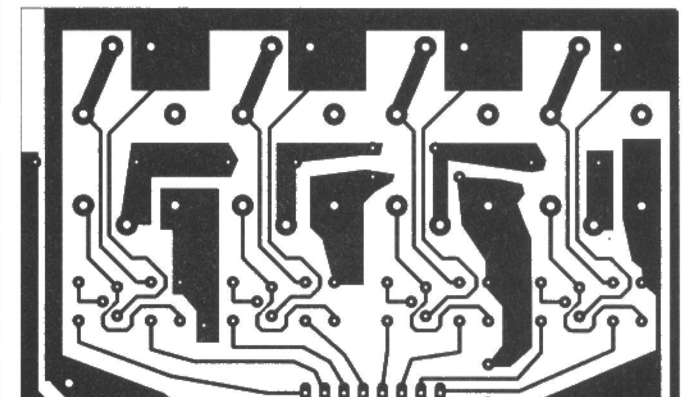

4-Go Rocket Launcher - relay board

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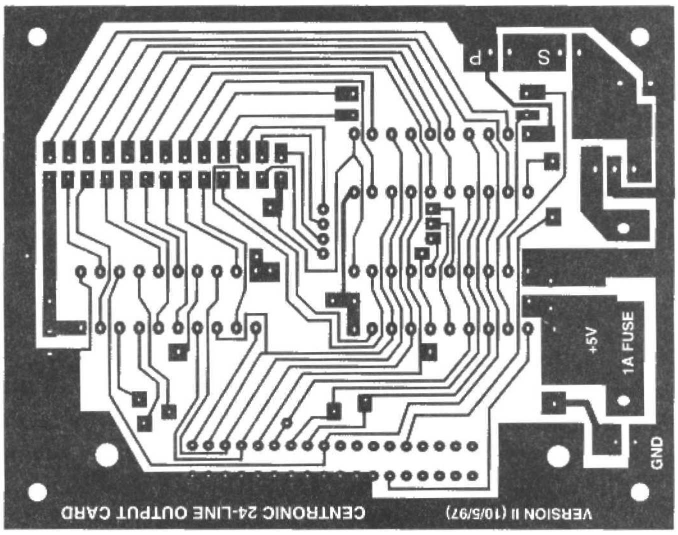
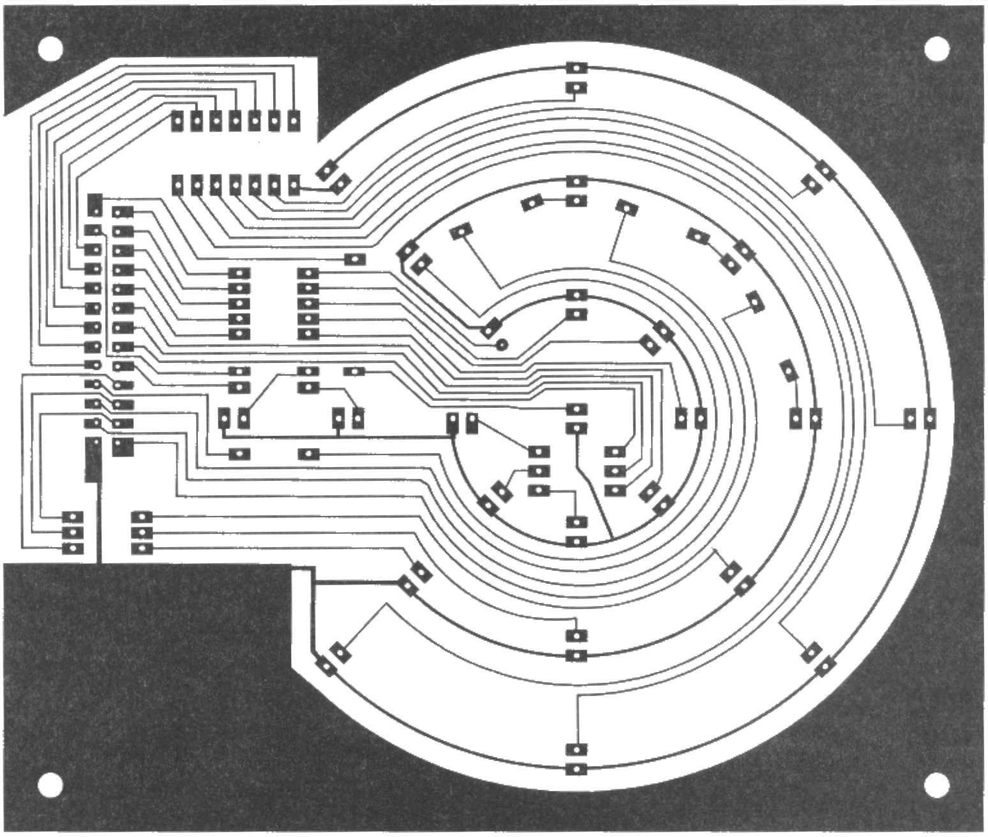


Computer Controlled Light Show - Output board



Computer Controlled Light Show - Display board

Around the Corner

Until recently, the major advances in DVD (digital versatile disc) seemed to have been in the area of hype. Now we can see that a clear standard and development path has been laid out, and already some PCs incorporate DVD drives instead of CD-rom drives. Of course, the DVD drives can also read CD-roms.

The basic single sided single layer DVD, which is available now, holds seven times the data of one Compact Disc: 4.7 gigabytes per single side, as compared to 680 megabytes for CD. There are other options for the future: a dual-layer, single-side option, for even higher capacity: 8.5 gigabytes on a single side, or 17.0 gigabytes on a double-sided disc.

Are CDs obsolete?

Refinements incorporated in DVD as compared with CD-rom include smaller pit dimensions, a more closely-spaced track and a shorter-wavelength laser (visible red 650 and 635 nanometre for DVD, as against 780 nanometre infra red for CD-rom). The lens system has also been improved to give sharper focussing.

The improvements in the error correcting technology are of great importance. The Reed Solomon Product Code error correction system on DVD is approximately ten times more robust than the one on the current CD system.

At least some DVD systems are to be rewriteable. Apart from the facts that DVD is not yet widely available, and certainly not in portable form, and that DVD discs are larger than Minidiscs (see last month's Round the Corner), DVD should be a more attractive proposition for consumers.

Whichever system is widely accepted, so long as one of them is, then it may be possible to buy your recorded music in a different way in the future. For example, you might choose your own track list and have the computer in the record shop make a custom Minidisc or DVD for you. Or perhaps you would purchase and download individual tracks over the Internet (legally, of course).

DVD is also for video, but the CCIR-601 digital video standard specifies a video rate of 167 megabits per second. At this bit rate, the 4.7 gigabyte capacity of a standard DVD could only store roughly four minutes of digital video. The answer to this is MPEG compression, which can store over two hours of video on a single sided, single layer disc.

MPEG2 works by analysing the video picture for repetition. Over 97 percent of the digital data that represent a video signal is redundant, and can be removed without visibly harming picture quality.

As implemented for DVD, MPEG2 encoding is a two-stage process, where the signal is first evaluated for complexity. Then, higher bit rates are assigned to complex pictures and lower bit rates to simple pictures, using an "adaptive," variable bit-rate process. The DVD format uses variable bit rates with a range of up to 10 megabits per second. Although the "average" bit rate for digital video is often quoted as 3.5 megabits per second, the actual figure will vary according to movie length, picture complexity and the number of audio channels required.

The picture is stored as component video rather than in an encoded form, which should open the door to higher resolution television pictures. Certainly the PAL system, as it is normally implemented, loses almost half the horizontal detail which could be available. Perhaps this is one reason for the slow takeup of wide screen televisions: the picture is big, but blurred and short on detail. I have heard sour comments that some people can get that sort of picture just by taking off their glasses, so that the magic of wide-screen has some way to go yet.

On the other hand, most people seem to be happy with standard VHS recordings, which lose much of the detail available in PAL pictures, so maybe if DVD takes off as a consumer music and video standard, it will be because it is conveniently backwards-compatible with CDs.

Next Month...

Volume 27 no. 1 of *Electronics Today International* will be in your newsagent nearly as fast as 1998 itself - on 2nd January 1998 ... our leading feature will be packed with details about the current ranges of microcontrollers ... Ray Haigh's custom Loop Aerial for medium wave and portable radios ... a new switched mode Power Supply from Bob Noyes ... Robert Penfold's four-channel infra red remote controller... a multi purpose one-short timer ... plus all the regulars, and more.

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